SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

DECEMBER 1899.

GENERAL PHYSICS.

1834. *Surface Tension of Aqueous Solutions.* **C. Forch.** (Wied. Annalen, 68. 4. pp. 801–816, August, 1899.)—Slight traces of a fatty acid in water produce only a slight diminution of the surface tension at first. If the relation is plotted graphically, ordinates representing surface tensions and abscissæ being $\sqrt[3]{m}$, the curve in its initial portion is parallel to the axis of abscissæ. This changing-point of the curvature approaches lower values of m as the amount of carbon in the acid increases. E. E. F.

1835. *Automatic Mercury Pump.* **R. R. Lawrence.** (Science, 9. pp. 510–511, 1899.)—The novelty about this pump is its electrical control, which is so arranged that sparks made by contact do not foul the mercury. E. E. F.

1836. *Efflux of Gases.* **R. Emden.** (Wied. Annalen, 69. 1. pp. 264–289, September, 1899.)—The author describes the phenomena of periodic condensation observed in the efflux of gases from narrow openings, and photographs them by Dvorak's method of striæ. He shows that stationary sound waves are produced in all gases as soon as the pressure exceeds 1·9 atmospheres. E. E. F.

1837. *Transformation of Iron and Steel.* **H. Le Chatelier.** (Comptes Rendus, 129. pp. 279–282, July 31, 1899.)—The author studies the recalescence and magnetic transformation of iron and steel by means of experiments involving very slow changes of temperature. In steel there is no simple contraction on cooling; but at the transformation-point there is an expansion of one constituent and a contraction of the other, which, in steel containing 0·9 per cent. of carbon, exactly neutralise each other. In iron the changes of volume are still more complicated. Transformation is gradual, there being no fixed point of transformation as in other simple bodies. The author compares the behaviour of iron with that of selenium, which is stable only between 60° and 214°. Outside these limits only the amorphous variety, vitreous or liquid, is stable. E. E. F.

1838. *Equations of Condition.* **O. Wiedeburg.** (Wied. Annalen, 69. 1. pp. 66–82, September, 1899.)—The author arrives at Gouy's views along an independent line of argument. Gouy considers a system in stable equilibrium, upon which a certain external influence is exerted, consisting of a change of shape or volume, an addition of heat or electric charge, or generally, as the author would express it, in a change of a certain quantity value M of the system. The effects of this influence are of two kinds: either unenduring like changes of temperature, pressure, electric potential, *i.e.*, of a foreign intensity value J'; or enduring, like changes of shape, volume, chemical composition, *i.e.*, of a foreign quantity value M'. Gouy concludes that "unenduring effects are directed against the external influence, while enduring effects favour it." The author puts this in a slightly different form: If the effects $\delta J'$ and $\delta M'$ are regarded as the causes of "reactions" of the system upon the primarily modified value M, it may be said that the reaction δM has a sign opposite to that of the original influence δM if due to unenduring effects $\delta J'$, but the same sign if due to enduring effects $\delta M'$.

E. E. F.

1839. *Recent Research on Chromosphere.* **H. Deslandres.** (Paris Soc. Franc. Phys. Bull. 130. pp. 2–4, 1899.)—A paper similar to that referred to in Abstract No. 899 (1898). C. P. B.

1840. *Gallium in the Sun.* **W. N. Hartley and H. Ramage.** (Astro. Phys. Journ. 9. pp. 214–220, 1899.)—The authors, in the course of their examination of minerals, meteorites, &c., have found the element gallium so common a constituent, though always in very small quantity, that they deemed it advisable to determine if there were any traces of it in the sun. Attention was confined to the two best known lines of gallium at λλ 4172 and 4033. Photographs of the spectra of specially prepared pure iron, various gallium compounds, and the solar spectrum were obtained with the large (21 feet) Rowland concave grating spectroscope of the Royal University of Ireland, and the plates carefully measured. After considering the possible coincidences with adjacent lines due to other elements, the authors conclude that gallium is present in the sun. C. P. B.

1841. *Heat Radiation of the Stars.* **G. E. Hale.** (Astro. Phys. Journ. 9. pp. 360–362, 1899.)—The author commences by reviewing the negative results of C. V. Boys, who used in connection with a 16-inch reflecting telescope a radio-micrometer sensitive enough to show the heat equivalent to that of a candle 1·71 miles away. E. F. Nichols, of Dartmouth College, has spent much time in perfecting the radiometer, and the present form of the instrument is for certain purposes considered superior to either the radio-micrometer, bolometer, or thermopile. In July, 1898, Nichols was invited to test his instrument at the Yerkes Observatory, and the apparatus was installed in the heliostat room, where the stability was so perfect that deflections to tenths of a millimetre could be observed. The radiometer used consisted of a suspension system formed of two mica discs, each 2 mm. in diameter, blackened on one face, and supported by a light cross arm on either side of a thin glass staff, hung by an exceedingly fine quartz fibre in a partial vacuum. Both vanes were exposed to the radiation of the sky at the focus of a silvered glass mirror of 24 inches aperture, fed with light by a siderostat outside. The rays entered the radiometer through a small window made of *fluorite.* With the apparatus so arranged a deflection of 0·1 mm. would be given by a candle fifteen miles distant, neglecting loss by reflection and atmospheric absorption. Seven determinations of the heat radiation of Arcturus gave a mean deflection of 0·60 mm. Vega gave a mean deflection of 0·27 mm. Although the quantitative value of these results is not insisted upon, the author considers that they show the reality of the detection of stellar heat radiation. C. P. B.

1842. *Variations of Apparent Horizon.* **F. A. Forel.** (Comptes Rendus, 129. pp. 272–274, July 31, 1899.)—The author has recently been engaged in the study of aerial refractions and mirages on the surface of Lake Léman, and in the course of his work has been able to make some observations on the displacement of the apparent horizon. The work was carried out at Morges, in a laboratory on the border of the lake, where he could command a length of horizon of about 16 kilometres. Observations were made with a telescope mounted on a stone pier of such height that the horizon was 5 or 6 kilometres distant, and the level was determined by sights, both direct and with an artificial horizon. The angular differences between the *true* and *apparent* horizon varied from +501″ and −272″, showing a total variation of 773″, or over 13′ of arc.

The factors causing this difference are: temperatures of the air and water, humidity and agitation of the air, direction and quality of wind, and variations of atmospheric pressure.

Tables are given of the various values observed, from a discussion of which the following general rules are deduced:—

1. The possible error in the position of the true horizon as deduced from observations of the apparent horizon is greater when the air is calm than when it is agitated.

2. It is greater when the air is warmer than the water.

3. Since the observations are more uncertain when the air is calm and warmer than the water, morning observations are better than those made in the afternoon. C. P. B.

1843. *Temperature Variations in the High Atmosphere.* **L. T. de Bort.** (Comptes Rendus, 129. pp. 417–420, August 21, 1899.)—Since April, 1898, more than a hundred unmanned balloons (*ballons-sondes*) have been sent up from Trappes, of which seven exceeded the altitude of 14,000 m., twenty-four of 13,000 m., and fifty-three of 9,000 m. Kites have also been used. In recent months both the old thermometers and the new improved thermometers have been employed, in order to secure comparable results. Thus continuous temperature observations, extending over more than a year, have been obtained for the first time. They show greater variations in the temperature of the higher strata than had been expected. The isothermal of 0° may not be met with below 4,000 m.; the isothermal of −25° has been found at an altitude of 3,000 m. in winter, and at 7,000 and even 8,000 m. in September. The isothermal of −40° is generally near 9,000 m., but it has gone up higher at the end of the summer, and descended to 6,000 m. during winter. A temperature of −50° has never been observed below 8,000 m.; in September, 1898, and July, 1899, it did not occur below 12,000 m. The higher strata of the atmosphere seem to be warmest towards the end of the summer, and coldest towards the end of the winter. But the temperature may change greatly in the course of a few days. Thus the isothermal of −40° was at an altitude of 8,500 m. on March 14th last, and at 6,600 on March 24th. H. B.

LIGHT.

1844. *Astronomical Telescope Objectives.* **H. Harting.** (Zeitschr. Instrumentenk. 19. pp. 104–110, 1899.)—A discussion of methods of calculation based upon first assuming the axial thicknesses of the lenses to be negligible, and then applying the requisite corrections. A numerical example of the calculation is given. A. D.

1845. *Paris Exhibition Siderostat.* **P. Gautier.** (Paris, Soc. Phys. Séances, 1899, 1. pp. 29–50.)—A paper similar to that referred to in Abstracts Nos. 1131 and 1657 (1899). EDITOR.

1846. *Corrections for Chromatic and Spherical Aberration in Astronomical Telescopes.* **R. Steinheil.** (Zeitschr. Instrumentenk. 19. pp. 177–183, June, 1899.)—A comparison of three objectives, comprising that of the Königsberg heliometer, another similar lens, also by Fraunhöfer, and a new lens of Jena glass. The errors introduced by the secondary spectrum tend greatly to exceed those due to spherical aberration. A. D.

1847. *Reversing Prism.* **B. Wanach.** (Zeitschr. Instrumentenk. 19. pp. 161–177, 1899.)—The reversing prism with two refractions and one reflection, used for reversing images without deviating the axis of the rays, is fully discussed, with reference to its applications. A. D.

1848. *Optical Properties of Minerals.* **H. Rosenthal.** (Wied. Annalen, 68. 4. pp. 783–800, August, 1899.)—The author studied the absorption, emission, and reflection of quartz and mica, and compared them with the properties of glass in the region extending from 5,000 to 10,000 $\mu\mu$. In this region the bodies mentioned have characteristic properties which make them specially valuable for testing Kirchhoff's law of radiation. The relation between emission, absorption, and reflection formulated by that law is strictly verified. E. E. F.

1849. *Dispersion of Selenite.* **W. König.** (Wied. Annalen, 69. 1. pp. 1–11, September, 1899.)—The author solves the problem of determining the mean wave-length of a group of rays by photographing an interference phenomenon whose dependence upon wave-length is known, and determining the wave-length from the distance between the interference fringes. To obtain conditions as uniform as possible the interference fringes of a selenite wedge between crossed and between parallel Nicolls are photographed. The author finds the mean wave-length of curve of sensibility of ordinary Schleussner plates to be 428 $\mu\mu$.

E. E. F.

1850. *Bravais Points.* **P. Lefebvre.** (Comptes Rendus, 128. pp. 930–933, 1899.)—In a centric optical system of foci FF′ and optical constant H a real isosocles triangle can be formed with FF′ as its base and $\sqrt{H}$ for its sides. The summit of this triangle is called by the author the "pole" of the system. If O is this pole, and B and B′ are the Bravais points, OB may be made to coincide with OB′ or its prolongation by making it rotate round the pole O by a certain angle called by the author the "characteristic angle." To construct the image of an object it suffices to turn the radius vector joining the pole to the foot of the object on the axis round the pole through the characteristic angle. The foot of the image then lies on the axis at the end of the radius vector or its prolongation. The image is upright in the first case, and reversed in the second. Its ratio to the object is equal to that of the distances of the pole from the foot of the image and the object respectively, multiplied by the refractive index of the first medium with respect to the second. A centric optical system is completely determined when the axis, a pole, the characteristic angle, and the refractive indices of the extreme media are given. From these data the foci, principal planes, and nodal points can be immediately deduced. E. E. F.

1851. *Kirchhoff's Law.* **A. Cotton.** (Astro. Phys. Journ. 9. pp. 237–268, 1899; also Revue Générale des Sciences, February 15, 1899.)—This is a somewhat lengthy discussion of the position at present held by Kirchhoff's law in the explanation of the various phenomena of emission and absorption of radiant heat and light. C. P. B.

1852. *Blue Steam Jet.* **A. Bock.** (Wied. Annalen, 68. 4. pp. 674–687, August, 1899.)—The blue steam jet described by Helmholtz has a colour of a composition strictly identical with that of the blue of the sky, the intensities of the components being, in accordance with Rayleigh's law, inversely as the fourth power of their wave-lengths. Under conditions of illumination similar to those obtaining in the atmosphere the blue steam jet shows a whitish colour which, when observed at right angles to the ray, can be made to disappear by turning the analyser. Examination with intense concentrated light shows that the red, yellow, and green rays are polarised, whereas the blue and the violet rays are unpolarised, the result being a phenomenon analogous to Tyndall's "residue blue." The transmitted ray shows reddish-yellow colouration. Regular diffraction does not occur in the blue jet. The jet is invisible when illuminated by red light, but appears distinctly in a blue light, and therefore behaves like a blue body. It is probable that the diameter of the droplets is equal to the wave-length of the blue rays. E. E. F.

1853. *Pressure in Radiometers.* **E. Riecke.** (Wied. Annalen, 69. 1. pp. 119–124, September, 1899.)—The discrepancy between the author's values and those found by Donle is due to an error in the reduction to c.g.s. units and to an imperfect estimation of the moment of inertia of the paddle-wheel. When these errors are corrected values are obtained for the pressure on the radiometer vanes which closely agree with those of Donle. E. E. F.

1854. *Dispersion Model.* **J. H. Vincent.** (Phil. Mag. 46. pp. 557–563, 1898.)—A spiral spring is suspended horizontally by a large number of threads, and is weighted by bullets. To each bullet is attached a weight by another thread. One end of the spring is driven by a metronome, and at a certain frequency there is no transmission of the wave motion. E. E. F.

1855. *Polarisation by Total Reflection.* **R. Geigel.** (Wied. Annalen, 68. 4. pp. 698–704, August, 1899.)—In ordinary cases of total reflection no polarisation of the emergent beam is noticeable. The author has, however, observed such polarisation by means of a hexagonal prism in which a beam is totally reflected a large number of times. Polarisation in the plane of incidence begins to appear after the forty-fourth reflection. The probable explanation is that the component normal to the plane of incidence emerges into the rarer medium and is lost. Light of all visible wave-lengths behaves in the same manner. E. E. F.

1856. *Molecular Rotatory Power.* **H. Pottevin.** (Journ. de Physique, 8. pp. 373–376, July, 1899.)—Pribram has shown that the rotatory powers of aqueous solutions of tartaric acid go on diminishing as we add progressive quantities of methylic, ethylic, or propylic alcohol, or of formic, acetic, or propionic

acid. The author finds that formic and ethylic aldehydes act in the contrary sense, and that the increases in the molecular rotatory power depend not only upon the relative proportions of the aldehyde and the tartaric acid but also upon the proportion of water which is present. Formic aldehyde acts in the same dextrogyric sense upon sugars, upon left-handed amylic alcohol, and upon left-handed essence of matricaria (fever-few): it appears to have no influence upon essence of turpentine.
A. D.

1857. *Optical Properties in an Electric Field.* **W. Voigt.** (Wied. Annalen, 69. 1. pp. 297–318, September, 1899.)—The author examines the Hertzian equations with a view of finding whether any electric effects analogous to Zeeman's magneto-optic effect can be predicted from them. When the field is regarded as dependent upon the presence of ponderable matter, and the field components are introduced in their lowest possible power, the formulæ yield the electro-optic phenomena observed by Pockels in acentric crystals, as well as the Kerr effect. For media with sharp absorption lines the formulæ indicate a definite influence of an electric field in the shape of doublings or displacements. Some remarkable converse phenomena also follow, such as the production of a constant electric field in acentric crystals, and a variation of the inductivities of centric crystals and of isotropic bodies by the action of light. E. E. F.

1858. *Intensities of Zeeman Components.* **W. Voigt.** (Wied. Annalen, 69. 1. pp. 290–296, September, 1899.)—The author attempts to find an explanation of the differences in the intensities of the components into which a simple spectrum line is split up in the Zeeman effect. The theory he gives involves an amplification of the Hertzian equations, the resistances opposing the oscillations of the vectors characteristic of each spectrum line being assumed to vary with the strength of field. This assumption also explains the appearance of previously unknown absorption lines when in the magnetic field, and Egoroff and Georgiewsky's observation of the partial polarisation of the light of a monochromatic flame which is viewed at right angles to the lines of force and not subjected to spectrum analysis. E. E. F.

1859. *Kerr Phenomenon.* **H. Abraham** and **J. Lemoine.** (Comptes Rendus, 129. pp. 206–208, July 24, 1899.)—Experiments on the gradual but rapid decay of the birefringence when the field is abolished. Disruptive discharges are used, and the light from the spark itself is examined through the Nicol. When the spark is set at different distances the light has to traverse different lengths of path before it passes between the condenser plates where it is acted upon in the electric field. When the source of light is at a greater distance, more time has been allowed to enable the Kerr-phenomenon-producing condition to die away, and it is found that the electro-optic phenomenon is reduced to one-half in one 400,000,000th part of a second. A. D.

1860. *Spectra of Oscillating Discharges.* **G. A. Hemsalech.** (Comptes Rendus, 129. pp. 285–288, July 31, 1899.)—The author studies in detail the influence exerted by a self-induction in the discharge circuit upon the spectrum of an oscillating spark discharge. The first effect of the introduction of the self-induction is to lower the temperature, and thus eliminate the lines due to the surrounding gas from the spectrum of the spark. A table of the lines displayed by bismuth is given for three different values of the self-induction. In hydrogen under atmospheric pressure the lines due to the oscillating discharge are sharp, and this sharpness is not interfered with by the sparking distance. By employing 0·0038 henry the author has obtained lines which ordinarily only appear in Geissler tubes. E. E. F.

1861. *Red End of Argon Spectrum.* **C. Runge.** (Astro. Phys. Journ. 9. pp. 281–283, 1899.)—The author has recently been furnished with photographic plates specially sensitised for the region λ 7500, in the extreme red, and has obtained photographs of the argon spectrum with a concave Rowland grating of 1 metre radius, extending from λ 7207 to λ 8015. A table of the lines and relative intensities is given. C. P. B.

1862. *Structure of Hydrogen Lines in Solar Spectrum.* **L. E. Jewell.** (Astro. Phys. Journ. 9. pp. 211–213, 1899.)—The wave-length of Hδ, the blue line of hydrogen, has been given a certain value by Rowland in his table of standard wave-lengths, but this has been thought to be about one-tenth of an Ångström unit in error by some spectroscopists. The author of the present paper, who is responsible for the measurements from which Rowland's table is compiled, has remeasured the plates, and, finding no error in evidence, explains the discrepancy by the fact that the structure of the solar spectrum at this point has some effect on the position of maximum intensity which is chosen for the centre of the line. The measurements of hydrogen lines obtained during a solar eclipse or from a vacuum tube are not complicated by the presence of neighbouring lines, and thus a slight difference in *estimated* wave-length is possible. C. P. B.

1863. *Efficiency of Spectroscopes.* **H. C. Lord.** (Astro. Phys. Journ. 9. pp. 191–202, 1899.)—The difficulty involved in the mathematical analysis of the various combinations of optical systems for a spectroscopic train is in many instances complicated by the resulting integrals being indeterminate (directly). To lessen this the author has developed a graphic method whereby the curves corresponding to the integrals may be constructed by use of the planimeter, and consequently the comparison of various systems made with greater ease. The cases he discusses are: (1) a *bright* slit of angular width σ on a *dark* background; (2) a *dark* line of angular width σ on a *bright* background; (3) a slit of angular width σ illuminated by light of all except certain stated wave-lengths, viewed through a dispersive train (*e.g.*, the solar spectrum). The curves obtained are illustrated by actual examples calculated for well-known spectroscopes, and they show by inspection the relations existing between the slit width, aperture and focal length of lenses, and grain of photographic plate; so that, if one or more are varied, the effect on the performance of the instrument can be predicted to a certain extent. C. P. B.

1864. *Concave Grating Stellar Spectroscope.* **S. A. Mitchell.** (Astro. Phys. Journ. 10. pp. 29–39, June, 1899.)—A short account has previously been given of the promise of Rowland's concave gratings in the photography of stellar spectra (Astro. Phys. Journ. 8. p. 157, March, 1898), and the present paper gives the results obtained with apparatus specially designed for the purpose. The usual method of working with the concave grating is to mount slit, grating, and camera on the circle having its radius equal to half the radius of curvature, but this would necessitate the employment of a subsidiary telescope to project an image on the slit. In the direct method adopted the slit is dispensed with, and the light from the star, after diffraction and reflection from the grating surface, is brought to focus on a curve situated about half the radius of curvature from the grating. The spectrum for a short distance on either side of the axis is practically normal. The grating used has a radius of curvature of *one* metre, and is ruled with 7,219 lines to the inch, the ruled surface having an area $2 \times 5\frac{3}{4}$ inches. This was mounted on the $9\frac{1}{2}$-inch Hastings refractor, and although this is on the sixth floor of a building in Baltimore, excellent results have been obtained. Later the grating was used at the Yerkes Observatory. The lines are adjusted parallel to the equator, so that errors of the driving clock will not spoil the definition of the spectrum lines. As the light passes through neither object-glass nor prisms, there is little absorption of the ultra-violet region. The photographs in the *first* order were $1\frac{1}{4}$ inches long from Hβ (λ 4861) to the extreme ultra-violet, and usually both first and second orders were obtained on one plate. The hydrogen series in such stars as Sirius is specially well shown, twenty-one lines being identified on one plate. Of special interest are the results of two plates obtained of the spectrum of the Orion nebula with exposures of about 3½ hours, the wave-lengths of twenty-nine lines being given in the article. A method of using the grating so as to give absolute wave-lengths for work on motion in the line of sight is also given, and a *résumé* of the advantages of using concave gratings. C. P. B

1865. *Spectroscope of Fixed Deviation.* **P. Pellin** and **A. Broca.** (Paris, Soc. Phys. Séances, 1899, 1. pp. 24–29.)—A paper similar to that referred to in Abstract No. 1480 (1899). EDITOR.

1866. *Becquerel Rays.* **J. Elster** and **H. Geitel.** (Wied. Annalen, 69. 1. pp. 83–90, September, 1899.)—The authors have made another attempt to discover the origin of Becquerel rays, but again without success. Thinking that the radiation might be influenced by the impact of kathode rays, they exposed a piece of pitch blende from Joachimsthal to kathode radiation, and determined whether that produced any difference in the Becquerel rays. It did not. Nor could any influence of temperature be demonstrated. The authors believe the Becquerel rays to be Röntgen rays of small intensity, and they render this very probable by two further analogies which they have discovered. A magnetic field not only increases the resistance of a partial vacuum, but it also retards the discharge of an electrified body provoked by the impact of either Röntgen rays or Becquerel rays. An obvious explanation would be that the Becquerel rays are deflected by a magnet; but when the rays were made to produce a bright patch on a fluorescent screen no magnetic field could displace that patch. E. E. F.

1867. *Becquerel Rays.* **O. Behrendsen.** (Wied. Annalen, 69. 1. pp. 220–235, September, 1899.)—The author brings some further evidence in support of the identity of Röntgen and Becquerel rays. He found that the latter are capable of exciting fluorescence in a plate of fluorspar. He also definitely disproved the polarisation of Becquerel rays, which their discoverer had relied upon as a distinction from Röntgen rays. He obtained a highly active substance by sublimating powdered pitch blende. He calls this substance X-sublimate, and finds the radio-activities of uranium, pitch blende, and X-sublimate to be in the ratio of 1 to 8·47 to 52·24. Pitch blende shows a strong variation with temperature, in spite of Elster and Geitel's negative results. Cooling to − 50° produces a reduction of the activity. Heating to 100° increases the activity, but incandescence destroys it.

X-sublimate shows the same behaviour, and so does uranium, except that the increase on gentle heating is not so evident. The author believes that he succeeded in eliminating all sources of error, such as that due to convection. He does not believe in a complex atom, but favours the theory of unstable molecules.
E. E. F.

1868. *Radio-active Baryta and Polonium.* **F. Giesel.** (Wied. Annalen, 69. 1. pp. 91–94, September, 1899.)—The author has examined a large number of radio-active barium salts from de Haën's chemical factory. When crystallised fresh from the aqueous solution, they gradually increase in activity. After some days or weeks they reach a maximum, and after that the activity remains constant as long as the crystals are kept free from moisture. Even concentrated solutions of the salts have some activity, but that gradually disappears. The crystals first crystallised are the most active. The author has not succeeded in isolating the active element, whether radium or polonium. But by precipitation with sulphuretted hydrogen he has obtained a substance which exceeds the best barium salts in activity. The rays ascribed to polonium are more easily absorbed by metals than those ascribed to radium, and the former rays therefore yield better radiographs of the hand, &c., as they show more contrast. The author does not think that fractional crystallisation alone will yield more highly active substances.
E. E. F.

1869. *Polarised Fluorescence.* **G. C. Schmidt.** (Wied. Annalen, 68. 4. pp. 779–782, August, 1889.)—That uranium salts and certain solid solutions of aniline dyes in phthalic acid do not emit polarised fluorescence has been confirmed by the author by means of a new fluoroscope, in which the parallel beam from an arc lamp was changed into a convergent beam by a quartz lens, and was then allowed to enter the crystal under examination. A violet glass was placed in front of the lens. It transmitted the whole of the blue and violet, and a little of the red. The path of the beam through the crystal was observed from the side by means of a Nicol or a dichroiscope. Among the crystals thus investigated were the uranyl compounds of sodium and potassium acetates, and of ammonium nitrate. None of these showed any polarisation in their fluorescent light. Glass under pressure, which shows double refraction, failed to show polarised fluorescence. Uranium glass gave equally negative results, and so did carbon bisulphide containing a little chlorophyll, which shows a brilliant red fluorescence. Sohncke's rule, according to which the fluorescence of all bi-refracting crystals is polarised, has therefore several pronounced exceptions.
E. E. F.

1870. *Diffraction of Röntgen Rays.* **M. Maier.** (Wied. Annalen, 68. 4. pp. 903–916, August, 1899.)—This is a series of experiments made to determine the "wave-length" of Röntgen rays by means of diffraction. In the absence of regular reflection and of polarisation, the diffraction method is the only one available, and that method has not yielded anything like consistent results except in the hands of Fomm. The latter used a linear source of Röntgen rays, a slit parallel to it, and a screen behind the slit, on which he detected two systems of fringes, one on each side of the image of the slit, and one system in the image itself. The author, in endeavouring to repeat this experiment, used every variety of focus tube and altered the elements of the arrangement in every conceivable manner, but without success. It was only when he had recourse to ordinary Crookes or Hittorf tubes that he obtained the fringes sought, or rather the first minimum within the image. The distance between the line of light and the slit was 200 mm., between the slit and the screen 180 mm., and the width of the slit was 0·1 mm. The resulting wave-length was 15 $\mu\mu$ consistently with two tubes. That would be about $\frac{1}{30}$ of the wave-length of ordinary light, and that value agrees well with that obtained by Fomm, though it remains to be proved that we are dealing with true diffraction. E. E. F.

1871. *Diffraction of Röntgen Rays.* **H. Haga** and **C. H. Wind.** (Wied. Annalen, 68. 4. pp. 884–895, August, 1899.)—The "interference fringes" produced by Röntgen rays in Fomm's experiment, and used by him for determining the wave-length of Röngten rays, are, according to the authors, nothing but a hitherto unknown optical illusion. That they are not diffraction fringes is shown by an experiment with a tapering slit, which produces two fringes representing Fomm's "first minimum." The fringes run alongside the two edges of the image of the slit, but always keep parallel to them, instead of diverging from them in the narrower portions. They eventually cross. The illusion is produced along the edges of penumbra. The edge of the geometrical image appears brighter where the penumbra begins, and of course darker on the negative. Hence the dark fringe. This reasoning does not, of course, explain away Fomm's system of fringes, but they are doubtful in any case. The authors do not reject the possibility of Röntgen rays producing diffraction phenomena, and they describe, in fact, a curious periodic broadening of a tapering slit image, which would indicate a spectrum consisting of several bands in the very extreme ultra-violet. But the wave-length guessed at is only of the order of 0·1 $\mu\mu$. E. E. F.

HEAT.

1872. *Thermometric Corrections.* **F. Grützmacher.** (Wied. Annalen, 68. 4. pp. 769–775, August, 1899.)—The author describes the process of thermometer testing adopted at the Reichsanstalt. All temperatures between 0° and 100° are now reduced to the international hydrogen scale. At higher temperatures the air thermometer is retained as a standard, since comparisons between that and the hydrogen thermometer are not completed yet. Within the limits mentioned the discrepancy between the two gas thermometers does not exceed 0·011°.

E. E. F.

1873. *Air Thermometer.* **L. Holborn** and **A. Day.** (Wied. Annalen, 68. 4. pp. 817–852, August, 1899.)—In the construction of gas thermometers for use at high temperatures, either porcelain or platino-iridium may be used as a material of the vessel. The authors decide on the whole in favour of the platinum alloy. Hydrogen passes freely through incandescent platinum, but nitrogen does not, and the nitrogen pyrometer is reliable up to 1,300°. The porcelain cylinder suffers under various drawbacks. It is not gaslight unless it is glazed, and the glaze begins to melt at 1,100°. At 1,450° the porcelain itself softens, and the vessel is filled with vapour given off by the glaze. The authors use a saltpetre bath for producing temperatures up to 750°, and a zinc bath up to 900°. Beyond that they heat by means of an electric current, since at the highest temperatures flame gases pass through the walls of the vessel. They determined the coefficient of expansion of the platinum alloy used with great accuracy. E. E. F.

1874. *Measurement of Temperature and Pressure.* **K. Scheel.** (Zeitschr. Instrumentenk. Beib. 9. pp. 69–72, 10. pp. 81–84, 11. pp. 89–92, 12. pp. 101–104, 13. pp. 109–111, 1899.) —This paper is a short history of the methods used for measuring temperatures and pressures, and especially of the latest developments. To render the mercury thermometer an exact instrument, at the suggestion of the *Bureau International*, a large stock of a certain quality of glass (*verre dur*) was obtained by Tonnelot, of Paris, and out of it a number of thermometers have been constructed. These, when systematically studied as to calibration and change of zero point, are found to give readings in accordance to two or three thousandths of a degree. The scale of temperature thus arbitrarily defined was compared with that of the hydrogen thermometer. In Germany the same object was attained in a more complete manner by determining the chemical composition and mode of manufacture of certain glasses suitable for thermometer-making; these are Schott & Co.'s "Normal thermometer glass," 16^{III} and a borosilicate glass 59^{III}, both of which show very small depressions of the freezing-point; the latter only 0·05° for the interval 0° to 100°. The latter glass is now almost exclusively used for thermometer-making, and some 370,000 thermometers have so far been tested in the German testing laboratories. Glass 59^{III} has such a high melting-point that it can be used for making thermometers to read up to 550°, the glass showing no signs of softening at that temperature. In order to prevent the mercury from boiling, the tube above the mercury is filled with carbon dioxide under high pressure, taken direct from a bottle of liquid carbon dioxide; the tube is then temporarily shut off by melting a little plug of shellac into the capillary, and under protection of this is fused off.

For low temperatures toluene has been found the most appropriate liquid to use; its scale has been compared with that of the gas thermometer. Lately Kohlrausch has adopted petroleum ether for the same purpose, as it remains liquid down to −200°, although somewhat viscous. For still higher and lower temperatures, either a platinum resistance thermometer or a thermo-couple is employed. The latter, which seems to be preferred in Germany, is made of Pt and Pt with 10 per cent. Rh (Le Châtelier's combination), the wires being about 0·6 mm. thick and 1·5 m. long, welded together at the ends, and enclosed in a porcelain tube for protection from furnace gases. The thermo-couple is available up to 1,600°; it has been compared with the gas scale, and temperatures up to 1,000° may (it is claimed) be measured to within 5°.

A description follows of certain mercury manometers, including those of Cailletet and Amagat for high pressures, and a less known form, the "broken" manometer, for attaining high pressure without the use of a great vertical height. Such an instrument has lately been adopted by the Reichsanstalt, and consists of twenty glass tubes, each two metres long, mounted side by side, and connected alternately at the top and bottom; the lower half of each tube is filled with mercury, the upper half with water, so that when pressure is applied to one end the mercury rises in all the even tubes and falls in all the odd ones. The twenty menisci are read by a mirror scale, and give the measure of the pressure. The glass tubes will stand 200 atmos. pressure; the maximum error is given as 0·02 atmos.

For high pressures the Reichsanstalt has adopted a piston manometer essentially similar to that of Amagat, the pressure being balanced by weights on a piston of measured diameter. This at 20 atmos. gave a reading 1/500 different to that of the mercury manometer. R. A. L.

1875. *Calorimetry.* **S. Lussana.** (Rivista Scientifica, 30. pp. 176–183, 1898.)—A calorimetric apparatus is described which is on the lines of that used by Fabre and Silbermann, but is so arranged that the calorimeter may be brought to and maintained at a temperature higher than the external temperature, while the substance to be studied may be maintained at a temperature equal to the external. A. D.

1876. *Conditions of Sensitiveness of the Thermopile and Bolometer.* **H. C. Pocklington.** (Cambridge Phil. Soc. Proc. 10. pp. 66–71, June 7, 1899.)—In the bismuth-antimony thermopile the bars should be 2 metres long and their cross-sections should be as 2·56 to 1; with the ordinary length of 2 cm. and this ratio of cross-sections the sensitiveness is greatest, and about one-fifth of the theoretical maximum, if the resistances of the thermopile and galvanometer are as 1 to 1·091. With the bolometer the galvanometer should have the same resistance as the strip, and the arms which are attached to the contacts of the strip with the galvanometer and battery should be respectively as large and as small as possible. If one of these arms is made with resistance equal to that of the strip, as is usually the case for practical reasons, the resistance of the galvanometer must be half or twice that of the strip, as the case may be, and the sensitiveness is less than the maximum by about 29 per cent. R. E. B.

1877. *Pressure, Volume, and Temperature in Fluids.* **E. H. Amagat.** (Journ. de Physique, 8. pp. 353–362, July, 1899.)—In the expression $(p+\mathrm{P})(v-a)=\mathrm{RT}$, if we use, instead of P (the internal pressure), the quantity $\pi=\mathrm{W}/3v=\Sigma r\phi(r)/3v$, where W is the virial of the interior forces, we obtain the simplified expression—

$$\left(p+\frac{\Sigma r\phi(r)}{3v}\right)v=\mathrm{RT},$$

in which the co-volume a disappears. Attention might then be confined to this term π; and discussion of the experimental results leads to the expression given in Abstract No. 1007 (1899). Applications to saturation conditions are discussed. R is slightly higher than $273^{-1}=0\cdot003663$; because at zero, when $p=1$ and $v=1$, the expression becomes $1+\pi=\mathrm{R}\times273$ and π can only become $=0$, so as to make the expression $\mathrm{R}\times273=1$, by referring to the mass of the gas at a vanishingly low pressure. But this is the aim that should be kept in view, so as to maintain the consistency of the thermodynamic equations; and if the zero isothermal is prolonged to the axis of pv, and if with the unit mass of gas as above defined it gives $(1+\epsilon)$ as the value of the ordinate p_0v_0 instead of 1, then the true unit mass referred to should be that unit divided by $(1+\epsilon)$. A. D.

1878. *Rectilinear Diameters and the Laws of Corresponding States.* **E. Mathias.** (Journ. de Physique, 8. pp. 407–413. August, 1899.)—If a fluid has a rectilinear diameter, its densities δ and δ' in the saturated states of liquid and vapour at any absolute temperature T are connected by a relation of the form—

$$\tfrac{1}{2}(\delta+\delta')=A-BT,$$

where B is the tangent of the slope of the diameter and A is another constant for the substance, given by $A=\Delta+B\Theta$, Δ and Θ being the critical density and absolute temperature. Thence follows at once—

$$B\Theta/\Delta=\left\{(\delta+\delta')/2\Delta-1\right\}/(1-T/\Theta)\equiv a,$$

and if the substance belongs to a group which conform to the laws of corresponding states this quantity a must be constant for the group. Now a is shown by observation to vary from 0·68 for nitrogen to 1·09 for ethyl propionate and not to have the same value even for the different members of a homologous series: hence the laws of corresponding states do not rigorously apply to rectilinear diameters except possibly in the neighbourhood of the critical states.

Amagat's procedure is unsatisfactory; for though it leads to a correct value of the critical density of ethylene, it gives one for ether which is 40 per cent. in defect of that deduced from experiment. R. E. B.

1879. *Specific Heat of Water.* **H. L. Callendar** and **H. T. Barnes.** (Electrician, 43. pp. 775–778, September 22, 1899. Paper read before the British Association, 1899.)—A current of water flowing through a fine tube is heated by an electric current through a platinum conductor in the axis of the tube, convective and radiative losses of heat being diminished by a vacuum jacket, with its external surface kept at the temperature of the inflowing water. When the steady state has become established the mass of water M that passes through the tube in a given time t is determined, and also the resulting rise of temperature $\delta\theta$ (by means of a differential platinum thermometer reading to 0·001° C.), the current through the conductor C, and the difference of potential E of its ends. H being the very small external loss of heat, the specific heat (in mechanical units) of water at its mean temperature in the tube J is given by—

$$JM\delta\theta=ECt-H.$$

The experiments extended from 0° to 60° C., $\delta\theta$ being generally from 8 to 10° and M about 500 grammes, and, on the assumption that at 15° C. the E.M.F. of the Clark cell is 1·4342 volts, the resulting formula (in joules per gramme per C. degree) for this range of temperature was—

$$J = 4{\cdot}181\,\{0{\cdot}9982 + 0{\cdot}0000045\,(\theta - 40)^2\}$$
$$= 4{\cdot}174 + 0{\cdot}00001881\,(\theta - 40)^2,$$

showing the minimum value to occur at 40° C. and the increase in J to be very rapid on approach to 0° C.

An interesting discussion of the results of other experimenters is given, and also reasons for provisionally taking for the range from 60° to 220° C. the formula—

$$J = 4{\cdot}181\,(0{\cdot}9944 + 0{\cdot}00004\,\theta + 0{\cdot}0000009\,\theta^2),$$

which represents Regnault's values diminished by a constant quantity. R. E. B.

1880. *Dilatation of Porcelain.* **T. G. Bedford.** (Electrician, 43. p. 780, September 22, 1899. Abstract of Paper read before the British Association, 1899.)—The linear expansion of Bayeux porcelain with rise of temperature is found to be represented fairly well by the formula—

$$l/l_0 = 1 + 0{\cdot}000003425\,l + 0{\cdot}00000000107\,l^2$$

between 0° and 600° C., and the results found for higher temperatures up to 830° C. do not depart far on either side from this curve. Reading microscopes were used to determine lengths, and temperatures were measured by the resistance of a platinum wire.

R. E. B.

1881. *Dilatation of Iron and Steel at High Temperatures.* **H. Le Chatelier.** (Comptes Rendus, 129. pp. 331–333, August 7, 1899.)—The expansions were determined from the tilting of a cast-silica mirror owing to the unequal expansion of its two supports, one of Sèvres porcelain and the other of the body studied. Three periods are to be distinguished, viz., the range of temperatures in which molecular transformations occur and the temperatures respectively lower and higher than this range.

Cast iron containing 0·057 per cent. of carbon and six steels containing percentages of carbon ranging from 0·205 to 1·21 were examined. I. At *low* temperatures their coefficients of expansion are sensibly identical, being about 0·000011 at ordinary temperatures and increasing regularly to 758°, where their value is about 0·000017. II. At *high* temperatures the expansion-coefficients increase rapidly with the percentage of carbon, being 0·000015, 0·000017, 0·000022, 0·000029 for the percentages 0·057, 0·205, 0·84, 1·21. III. For the range of transformation the observations were not satisfactory; but for the percentages of carbon 0·057, 0·205, 0·49, 0·84, 1·21, for which the mean temperatures of transformation were 840°, 768°, 728°, 730°, 725°, the contractions observed were 0·0026, 0·0023, 0·0021, 0·0008, 0·0010. A great number of the anomalies observed are explicable on the assumption that there occur, with more or less relative retardation, (i.) a molecular transformation of the iron, accompanied by a contraction of 0·0026, (ii.) the solution in this transformed metal of the iron carbide Fe_3C, accompanied by an expansion which would also be 0·0026 for a 0·09 percentage of carbon. R. E. B.

1882. *Kinetic Theory of Liquids.* **W. Voigt.** (Wied. Annalen, 69. 1. pp. 324–326, September, 1899.)—This is a reply to Jäger's criticism (see 1899, Abstract No. 1694) of the author's work. The author points out that he does not adopt rigid spheres as his atomic units, but "impact spheres" (*Stosskugeln*) defined as spheres constructed about molecules such that the centre of gravity of another molecule cannot penetrate into the sphere without experiencing a deflection. E. E. F.

SOUND.

1883. *Theory of Wind Instruments.* **F. Larroque.** (Comptes Rendus, 129. pp. 95–98, July 10, 1899.)—The tubes of brass instruments consist of a conical part with its vertex at the mouth of the player, and an enlarged portion at the further end. The effect of the enlarged end is to emphasise the higher harmonics. For the pitch of the note emitted is not altered if the cone is continued in its regular shape to the end of the tube. The portions situated between the cone and the brass resound to the notes produced in the tubes, and strengthen them while increasing the expenditure of wind. An increased expenditure of power implies an increased prominence of the overtones. E. E. F.

1884. *Beats of Strings.* **C. Maltézos.** (Comptes Rendus, 129. pp. 438–439, August 28, 1899.)—A mathematical theory of the vibration of strings indicates that the number of beats is proportional to the square root of the section, inversely proportional to the cube of the length, and inversely proportional to the root of the tension. Experiment shows, however, that the law of length does not hold good, the number of beats heard being nearly inversely proportional to the length. The author therefore concludes that his theory is not complete, and that the beats in a single string are probably due to a difference of elasticity in two directions across the sectional area. E. E. F.

1885. *High Pitches.* **F. A. Schulze.** (Wied. Annalen, 68. 4. pp. 869–883, August, 1899.)—The mathematical theory of Quincke's interference method of measuring high pitches is developed and its practice described. The author converts it into an objective method by closing the mouth of the tube with a cork carrying a small plate of mica on which sand is strewn. When the tones traversing the two branches of the Quincke tube coalesce to a maximum the grains of sand are projected upwards some 5 mm. The author verifies Stumpf and Meyer's criticism of Appunn's small tuning-forks. E. E. F.

ELECTRICITY.

1886. *Ribbon and Dark Lightning.* (Nature, 60. pp. 423–424, August 31, 1899.)—This article is illustrated by a reproduction of a photograph of lightning taken at Devonport (Tasmania) which shows a broad or ribbon-like flash with several dark ramified flashes. It is suggested that to obtain information as to the reason of the ribbon appearance systematic attempts should be made to photograph lightning with cameras having a known rate of movement, and an arrangement for determining the angular diameter of the ribbon. The dark flashes spreading from the main bright one are attributed to photographic reversal of previous bright flashes. Photography is thus held to give no support to the view that dark lightning has a real physical existence, and the letters from Lord Kelvin (August 10th) and W. J. Lockyer (August 24th) show that, when visually observed, dark lightning is an effect due to fatigue of the retina. E. H. B.

1887. *Electric Charge of Electrolytic Gas.* **W. Kösters.** (Wied. Annalen, 69. 1. pp. 12–33, September, 1899.)—The author attempts to determine the causes of the electrification of gases evolved by electrolysis. For this purpose he passed several such gases in the nascent state through liquids, and studied the power thus acquired of producing an electrometer deflection. Both hydrogen and oxygen were positively electrified by passing through sulphuric acid, just as they are when given off by the electrolysis of that acid. But oxygen from an oxygen tube, passed through a solution of caustic potash, showed positive electrification, whereas electrolysis of the same solution yields negatively electrified oxygen. The author considers that this points to the identity of the electrification observed on blowing through with what Lenard calls "waterfall electricity." Another peculiar phenomenon, first observed by Townsend, is that hydrogen, developed by electrolysis of dilute hydrochloric acid with platinum electrodes, is positively electrified, whereas its charge becomes negative after a while when carbon electrodes are used. E. E. F.

1888. *Loss of Electric Charge by Evaporation.* **H. Pellat.** (Paris, Soc. Phys. Séances, 1899, 1. pp. 14–24.)—A paper similar to those referred to in Abstracts Nos. 562 and 1375 (1899). Editor.

1889. *Disruptive Discharge.* **W. de Nikolaieve.** (Journ. de Physique, 8. pp. 432–433, August, 1899.)—To determine the precise effect of a disruptive discharge upon the intervening air, the author places a layer of cotton-wool, pressed between two ebonite rings, in the path of the spark. After the spark has passed, it is found that the cotton-wool is traversed by a canal about 6 mm. wide, with sides consisting of compressed cotton-wool. Soaking the cotton-wool in water or in vaseline oil enlarges the canal, but produces no essential difference in its structure. Sheets of aluminium or copper introduced in the path of the spark show depressions, which on microscopic examination are found to contain congealed droplets of the metal. E. E. F.

1890. *Genesis of the Electric Spark.* **B. Walter.** (Wied. Annalen, 68. 4. pp. 776–778, August, 1899.)—The author has collected some further evidence to show that every spark discharge is preceded by several tentative brush discharges which proceed from both electrodes. The positive brush is four or five times the length of the negative brush, and is much branched. There is a thickening in the central portion of the spark not covered by previous brushes, evidently due to an accumulation of energy in the central region. Even the final spark is not homogeneous, as is seen by a faint bridge which sometimes crosses a curved portion. E. E. F.

1891. *Pressure within the Spark.* **E. Haschek** and **H. Mache.** (Wied. Annalen, 68. 4. pp. 740–751, August, 1899.)—That the sudden increase of pressure produced by a spark is not due to its heat is proved by its subsidence immediately on the cessation of the spark, and by its magnitude, which may amount to 16 mm. in a pressure of 56 mm. The authors have arrived at what they believe to be a close estimate of the pressure within the spark itself. Having obtained an idea of the actual dimensions of the spark by photography, they measured the increase of pressure per unit surface of the vacuum tube by a specially constructed manometer. By reducing the total increase of pressure to the surface of the spark the pressure within the latter was obtained. In the case quoted it was 11·3 atmospheres. It was found to increase with the energy, the pressure of the gas, and the sparking distance. The authors point out a similar increase of pressure when an arc light is established. They believe the pressure to be intermittent, and estimate it at 2 to 3 atmospheres. They attribute the pressure in both cases to particles projected from the electrodes. It is higher in sparks between carbon electrodes than between electrodes of iron, zinc, or other metals. E. E. F.

1892. *Work Consumed in a Spark-Gap.* **E. Riecke.** (Wied. Annalen, 68. 4. pp. 729–739, August, 1899.)—In the course of some work with a 40-plate Toepler machine, originally designed for experiments on vacuum discharges, the author had occasion to determine the work expended in spark-gaps of different lengths. The influence machine was driven by a motor provided with a speed indicator. The voltage, current strength, and speed were taken with and without the spark-gaps. With a constant speed of 13 turns per second the watts per turn were found to be, for various lengths of gap—

Gap 2 cm.	1·64 watts	Heat	4·96	grm.-cal.	per sec.
„ 4 cm.	2·08 „	„	6·05	„	„
„ 6 cm.	3·27 „	„	9·56	„	„
„ 8 cm.	1·79 „	„	5·39	„	„

An interesting result brought out by the above table is that the work diminishes as the spark-gap is widened from 6 cm. to 8 cm. Since the difference of potential increases at the same time, it follows that the quantity of electricity discharged is a good deal less, and that is obvious from the appearance of the sparks. The author endeavoured to confirm the above results by substituting tubes filled with cadmium iodide solution for the spark-gaps. The results were then somewhat higher. E. E. F.

1893. *Conduction in Rarefied Gases.* **E. Bouty.** (Comptes Rendus, 129. pp. 152–155, July 17, and pp. 204–206, July 24, 1899.)—An isolated conductor (a flask) introduced between the armatures of a condenser actuated by a potential difference V, produces an increase in the capacity of the system, which is the same whether the flask be filled with a metallic substance (mercury) or an electrolyte, or whether its conductivity be due to a superficial film of moisture, inside or outside, and which is independent of the value of V. But a dry flask full of air produces only a trifling increase of capacity if the air be at the ordinary pressure: a non-conductor therefore acts differently from a conductor. Vacuum tubes act in this respect like air at ordinary pressure: the extremely rarefied air is a non-conductor, whatever the voltage. Geissler tubes (1 to 5 mm.) at moderate voltages act in the same way, but at high voltages their contents come to act as conductors (with a flash of light), and at certain intermediate critical voltages the tubes may act in one way or the other, according to surrounding circumstances not yet fully ascertained. These observations tend to tell against the idea of there being free ions or any electrolytic conduction at voltages short of those under which the electric elasticity of the gas breaks down. The relation between the electromotive force and the gaseous pressure is further examined in pp. 204–206. The general result is that the values of the electromotive force f corresponding to given values of the pressure p are, with tubes of different forms and condenser plates at different distances, proportional to one another; that within the limits tried $f = A\,(1 + Bp + Cp^{-1})$; that the term in p^{-1} preponderates at very low pressures, as if the molecules only tended to weaken the ether at their own locations; that when they are near to one another their mutual action increases the cohesion proportionately to their number; that B appears to be independent of the nature of the gas; that C appears, with less certainty, to be the same; that A increases somewhat with the molecular weight (1·00 for H, 1·55 for CO_2); and that if we measure p in millimetres of mercury, $B/C = 4{\cdot}4$. A. D.

1894. *Gaseous Conduction in Incandescent Lamps.* **J. Stark.** (Wied. Annalen, 68. 4. pp. 919–948, August, 1899.)—The fact that flame gases have considerable electric conductivity leads to the inference that the hot gases in the bulb of an incandescent lamp may be partly instrumental in conveying the current through the lamp. This is made very probable by the author's observation that the current can be tapped by inserting metallic electrodes in the bulb, which are not in contact with each other nor with the filament. The current through the gas is subject to deflection by a magnet. There is a well-marked difference in the behaviour of a glowing carbon filament when charged positively and when charged negatively. A negative charge is dissipated more easily than a positive one. This explains the difference in the attraction exerted by differently charged bodies upon the glowing filament. It also explains the unidirectional character of the tapped current through the inserted electrodes. The temperature of the filament is about 1,500° C. At that temperature the gas still acts more as a dielectric than as a conductor; but at 2,000° C. all gases are probably conductors, and then we have practically an arc lamp. E. E. F.

1895. *Conductivity of Gases exposed to Discharge Rays.* **J. J. Thomson.** (Cambridge Phil. Soc. Proc. 10. pp. 74–77, June 7, 1899.)—The properties of discharge-rays, or "Entladungs strahlen," were discovered and described by E. Wiedemann and Hoffmann (see Physical Society's Abstracts, 1897, No. 208). They emanate from a region through which an electric discharge is passing; they move in straight lines, are not deflected by a magnet, and are stopped by solids, liquids, and some gases, such as carbon dioxide. Their effect upon the electric conductivity of gases exposed to them is studied in the present series of experiments. The discharge is produced between two electrodes, which can be moved along the axis of a tube, keeping the distance between them constant. From the side of this tube an opening, closed by wire gauze, leads to another tube at right angles to the first, and has itself a lateral tube near its centre. Two aluminium cylinders with insulated wires along their axes are placed in these tubes in such a manner that one can be reached by a rectilinear path from the electrodes, while the other cannot be so reached. The author studies the rate of leakage of electricity between each cylinder and its axial wire for various pressures of contained air, and for exposure to different parts of the discharge. He finds that the Entladungs strahlen produce conductivity of the gases through which they pass, and that the effect is greater in hydrogen, and less in carbon dioxide, than in air. The radiation is emitted more copiously from the neighbourhood of the electrodes than from the rest of the spark: it appears therefore to be connected with the ionisation of the gas and its recombination. These phenomena are compared with the production of secondary rays when a gas is exposed to Röntgen radiation in which ionisation is taking place, and when Röntgen rays fall on a metallic surface; they are probably due to pulses arising from the sudden stoppage of the electrified ion. By bringing the gas experimented upon very near to the arc, and taking special precautions to prevent convection from the arc to the gas, the effect can be observed in air at ordinary pressure. J. L. H.

1896. *Motion of a Charged Ion in a Magnetic Field.* **J. J. Thomson.** (Cambridge Phil. Soc. Proc. 10. pp. 49–52, June 7, 1899.)—This treats of the motion of an electrically charged particle in a magnetic field, when the free path of the particle is so short that the effects of collisions form a dominant factor. The problem in hand is therefore complementary to the case of the kathode rays, in which the free path is so long that the effects of collisions are not appreciable. In the latter case the *acceleration* of the charged particle is, as usual, proportional to the force acting on it, but in the former case the *velocity* of the particle is proportional to the acting force. Starting from this ground, expressions are easily found for the components of the velocity of the charged particle, from which it appears that in a weak magnetic field the particle moves along a line of electric force, whereas in a very strong magnetic field the particle follows a line of magnetic force. In the general case there are component forces (1) along the line of electric force, (2) along the line of magnetic force, (3) in a direction at right angles to these lines. In this case, therefore, the path of the particle is a spiral.

These results show that, if we consider ions moving with different speeds in a magnetic field of constant strength, those ions which move at high speeds will travel along the lines of magnetic force, while those which move at lower speeds move along spirals. Now in the discharge of electricity through gases the velocity of the negative ion has always been found to be greater than that of the positive ion, and this difference of velocity has been shown to account for many of the differences between the phenomena at the positive and negative electrodes in a vacuum tube. In like manner the foregoing considerations account for the difference in behaviour of the negative glow and of the positive column in a magnetic field. In a strong magnetic field the negative glow follows the lines of magnetic force, whereas the positive column on the other hand does not do so, but follows a more or less spiral path, and this is what is indicated by the above theoretical considerations. T. P.

1897. *Hittorf's Dark Space.* **H. Ebert.** (Wied. Annalen, 69. 1. pp. 200–219, September, 1899.)—Hittorf's dark space is the narrow space immediately adjoining the luminous layer covering the kathode itself. As exhaustion proceeds, this layer increases in thickness. The author investigates the relation between the thickness of the layer and the exhaustion, and shows that the dark space increases in a geometrical series as the pressure decreases in another geometrical series, usually of different index. The relation may be put in the form—

$$\frac{d_1}{d_2} = \left(\frac{p_2}{p_1}\right)^m$$

In oxygen, a discontinuity occurs at a pressure of 0·7 mm., the point at which also a discontinuity occurs in the same gas as regards Boyle's law. E. E. F.

1898. *Diffusion of Kathode Rays.* **W. Kaufmann.** (Wied. Annalen, 69. 1. pp. 95–118, September, 1899.)—The absorption and diffusion of kathode rays by gases as observed by Lenard is studied by Perrin's electrical method. A beam of kathode rays emerging from a vacuum tube was made to traverse a metallic cylinder earthed through a galvanometer. Beyond the cylinder the rays impinged upon a metallic plate earthed through another galvanometer. Any current indicated by the first galvanometer would then be due to kathode rays absorbed or diffused in the cylinder. According to the results of Lenard, taken in conjunction with the author's own results, only a very small portion of the current is accounted for by absorption. The author finds that the quantity $\frac{bV}{p}$ is constant for any given gas, b being the diffusion, V the difference of potential, and p the pressure. It is 5,650 for nitrogen, 6,830 for CO_2, 6,380 for CO, and about 730 for hydrogen.

The author goes on to investigate the probable mechanism of the kathode rays. He concludes that the energy given off by the particles constituting them is only partly converted into kinetic energy of the gas molecules, leading to a rise of temperature, and that the other part is converted into oscillating motion of Prout's primitive atoms. The mass of such a primitive atom would be 0·038 (H = 1), and that of a radiant particle 0·00053. The hydrogen atom would thus consist of about twenty-six primitive atoms. E. E. F.

1899. *Mechanics of Kathode and Canal Rays.* **P. Ewers.** (Wied. Annalen, 69. 1. pp. 167–199, September, 1899.)—In determining the ratio *e/m* of the electric charge to the mass of an ion, a decided difference appears between the canal rays and the kathode rays. Whereas in canal rays the values of the ratio are quite in accordance with the supposition that projected atoms are at work, the behaviour of kathode rays does not admit that assumption. Either the mass projected would have to be 2,000 times smaller than a hydrogen atom, or an atom would have to convey a quantity of electricity 2,000 times as great as that which it is known to convey in electrolysis. The author has made a number of quantitative experiments tending to throw light on this subject. He does not share the prevalent opinion that canal rays consist of projected anode particles, since the quantity of electricity conveyed by them varies with the material of the kathode, but not with that of the anode. The author concludes that the canal rays consist of positive ions of the material of the kathode, but the matter thus conveyed to the wall is so small that it would require 288 hours of continuous working to deposit one milligramme of aluminium. About 11 to 18 per cent. of the energy supplied is given up by the canal rays in the form of heat. E. E. F.

1900. *Kathode and Canal Rays.* **O. Berg.** (Wied. Annalen, 68. 4. pp. 688–697, August, 1899.)—The author perforated the anode instead of the kathode, and obtained phenomena which are converse to those of Goldstein's canal rays, thus showing that rays from one electrode are propagated across gaps in the other. It remains certain, however, that the bulk of the work of transporting the electric charge falls to the kathode rays, and this is probably due to the fact that negative charges in a vacuum, as in the open air, are dissipated more readily than positive charges. There are other important differences. Anode rays are not capable of producing the brilliant phosphorescence obtained with kathode rays. They are, therefore, less noticed and less studied. They are not deflected magnetically to the same extent. According to Wehnelt, their direction is largely influenced by the position of the kathode, whereas kathode rays are not influenced by the situation of the anode. E. E. F.

1901. *Potential Gradient at the Anode.* **C. A. Skinner.** (Wied. Annalen, 68. 4. pp. 752–768, August, 1899.)—The potential gradient within the luminous layer immediately covering the anode is practically infinitesimal. Both Hittorf and Graham found that there was a sudden fall of potential at the anode, though not so great as that in Crookes' dark space. There is, in fact, a difference of potential between the metallic anode and the gas, amounting to, say, 20 volts. This difference increases to, say, 40 volts within the first few millimetres, but the point brought out clearly by the author is that no such increase takes place within the luminous layer immediately adjoining the anode. This luminous layer is usually 1 mm. or 2 mm. thick, and closely adheres to the anode. Another fact revealed by the author's experiments is that the greater the drop of potential at the anode the less is the potential gradient near the anode, and the greater is the distance from the anode at which the gradient becomes constant. In other words, a great anode drop means a thick anode layer. The anode drop depends, of course, upon the gas, the pressure, and the material of the anode. Generally speaking, those metals furnish the greatest anode drop which exhibit the least difference of potential when used as kathodes. E. E. F.

1902. *Phillips' Phenomenon.* **G. W. Walker.** (Electrician, 43. pp. 602–604, 634–635, August 18 and 25, 1899.)—A mathematical investigation of the luminous phenomena in Crookes tubes described by Phillips (see 1899, Abstract No. 683). The author assumes the luminosity to be due to the collisions of negatively charged particles moving under the influence of the magnetic field. Before the magnetic field is excited the distribution of velocities will be according to Maxwell's law; but the magnetic field will give a spin to the particles, and the new distribution of velocities will cause a new arrangement of the atoms. It is shown that the gas will rotate like a solid body—a result announced independently by Kelvin; and the author investigates in what manner the gas so set in motion will, under the influence of viscosity, approach the uniform distribution of velocities in the magnetic field. The luminosity at different distances from the axis is calculated for successive stages in this process, and the results are in general agreement with the phenomenon as observed by Phillips. J. L. H.

1903. *Reflection of Hertzian Waves.* **L. De Forest.** (Amer. Journ. Sci. 8. pp. 58–71, July, 1899.)—Using an exciter which is a compromise between the Lecher and Blondlot forms, the author investigates the nature of reflection at the ends of wires arranged as in a Lecher system. He determines the end capacities for the wires with ends bare, with brass balls at the ends, and under other conditions; the effect of bending the wires; the decrement of amplitude in the train of waves sent out; and also examines (with a coherer) the field near the wires for plane-polarised displacements. D. E. J.

1904. *Improved Lecher System.* **A. Righi.** (N. Cimento, 8. 4. pp. 34–36, 1898.)—The terminals of the exciting coil are attached to two vertical plates facing the secondary plates. The sparks of the exciter circuit pass between knots in contact with the primary plates. E. E. F.

1905. *Hertzian Oscillations.* **O. Murani.** (N. Cimento, 8. 4. pp. 36–44, 1898.)—An abstract of Murani's Istituto Lombardo paper, by Federico and Pasquini. The latter, in an additional note, confirm Murani's observation that Hertzian waves cannot be demonstrated by the coherer, since that responds to waves of all lengths. A node is shown at the mirror, and a constant deflection at any distance from it. E. E. F.

1906. *Dielectric Constants.* **W. D. Coolidge.** (Wied. Annalen, 69. 1. pp. 125–166, September, 1899.)—The author improves Drude's method of determining dielectric constants of bodies obtainable only in small quantities by introducing the condenser into the exciter circuit instead of the resonator circuit. This has the effect of considerably increasing the accuracy and sensitiveness of the method. The liquids studied included various acetates and benzoates, mixtures of ethyl ether, and chloroform, liquid chlorine, and other gases, as well as alcohol and water. The temperature coefficient of the dielectric constant of water is −0·432 per cent. per degree at 17°, which is well in agreement with previous results. Water shows anomalous dispersion of electric waves, but alcohol shows no electric dispersion at all. E. E. F.

1907. *Deformation of Dielectrics.* **P. Sacerdote.** (Comptes Rendus, 129. pp. 282–285, July 31, 1899.)—The author derives the formulæ expressing the electric deformation of dielectrics from the fundamental principles of electricity and the conservation of energy. He shows that all deviations from these formulæ are due to experimental errors. He finds that dilatation is the same in all directions normal to the lines of force, whatever be the shape and size of the condenser. As regards the causes of the dilatation, the author seeks them in the elastic deformation due to the known electric forces, and in a change of molecular state in the dielectric due to the ether disturbance. In gases the latter cause alone is at work, and brings about the electric contraction observed in them. E. E. F.

1908. *Polarisation of Dielectrics.* **F. Beaulard.** (Comptes Rendus, 129. pp. 149–152, July 17, 1899.) — According to Poisson's formula $\mu=\frac{1+2g}{1-g}$, where μ is the magnetic permeability, and g the ratio between the space actually occupied by magnetic particles (assumed spherical and of infinite permeability, disseminated throughout a non-magnetic medium) and the total volume of the substance. But in iron, if $\mu=500$, g is greater than the maximum possible ratio $n/(3\sqrt{2})$. Maxwell pointed this out: Betti makes $k=(\mu-1)/4\pi\{=3g/4\pi(1-3g)\}$ instead of $k=3g/\{4\pi(1-g)\}$; whence $\mu=(1-3g)^{-1}$; which gives possible values. Mossotti has applied the same order of ideas in electrostatic induction, K corresponding to μ; and Clausius has reached a result the same as that of Poisson, K replacing μ. Experiment shows that the Clausius and Betti formulæ equally well represent the facts. With mixtures of copper filings and paraffin, the specific inductive capacity *increases* as the proportion of copper is increased: this is contrary to the Maxwellian doctrine that it is zero for perfect conductors. **Potier** writes that the electromotive force at a point is equal to the sum of the electromotive forces which produce the currents of conduction and of displacement, and obtains the relation—

$$P=\frac{u}{c}+\frac{4\pi f}{K},$$

which for a conductor makes $K=\infty$. A. D.

1909. *Flow of Electrolytes through Partitions.* **F. T. Trouton.** (Electrician, 43. pp. 596-597, August 18, 1899.) — A beaker, pierced by a small hole, is placed in a second vessel, and both are filled with dilute acid. A lead plate in each serve as electrodes. When a current passes between the electrodes, the liquid rises in one or other of the vessels. Reversal of the current does not reverse the direction of the flow of the electrolyte. Any obstruction placed near the hole on one side or the other predisposes the level to rise on that side. At first the rate of rise is slight, but it increases, and the vessel from which the liquid is flowing is rapidly emptied, *i.e.*, the flow increases as the difference of level increases, and against the hydrostatic pressure. The action appears to be accompanied by an intermittent arc at the perforation, but this part of the phenomenon is not clearly described. The liquid is forced from the lower to the higher level by the formation of bubbles of vapour periodically at the perforation, on the side where the hydrostatic pressure is least, that is towards the lower level. The direction of flow depends upon which side of the hole the bubbles are formed. If a more dilute acid is placed on one side, the vapour tension is greater on that side, the bubbles form there more easily, and the flow is towards the denser side. The flow is always towards the side where bubbles are formed with most difficulty. R. A.

1910. *Electrolytic Conductivity of Solids at High Temperatures.* **W. Nernst.** (Zeitschr. Elektrochem. 6. pp. 41–43, July 13, 1899.)—The conductivities of rods composed of different metallic oxides or mixtures of oxides is investigated at different temperatures. The heating is done in a small electric oven and the temperature is measured by a platinum — platinumrhodium couple.

The conductivity of pure oxides increases very slowly with the temperature and also remains relatively small, while that of mixtures of oxides is of very much greater magnitude. [No numerical figures are given.] In order to test the conductivity at much higher temperatures, the rods are heated to incandescence by a current sent through them. The temperature can then be only roughly guessed at. The conductivities of mixtures of oxides, especially of those of Mg, Si, Zr, and the other rare earths are then found to be very great, a conductivity equal to that of the best conducting sulphuric acid solution being measured. At first alternating currents were used, but later it was found that continuous currents could keep one of the rods incandescent for hundreds of hours, without causing any disturbing decomposition. That the conduction is electrolytic and not metallic is evidenced by a number of considerations.

The transparency to light of all the oxides used is opposed to metallic conductivity. The author considers this a crucial test in all cases and applies it to the electric arc, and to the deep blue solution of Na in liquid ammonia, to both of which metallic conduction has been ascribed.

Mixtures of coloured oxides such as those of iron and cerium show a wandering of colour towards the kathode. Rods which contain much magnesia show quite appreciable growths at the kathode due to the burning of the magnesium formed there. Rods which are kept incandescent by continuous currents for a time show decided polarity, the kathode being always less bright than the anode. This is due to the rod becoming richer in the conducting material (dissolved oxide) near the kathode and poorer nearer the anode, consequently offering a higher resistance to the current near the latter. This unequal distribution only results to a certain extent, as diffusion, which tends to equalise matters, introduces a stationary condition. J. B. H.

1911. *Measurement of Self-Induction.* **G. W. Patterson.** (Wied. Annalen, 69. 1. pp. 34–65, September, 1899.)—The author compares the efficiency of two different methods of measuring self-induction—that of Maxwell as improved by Rayleigh, and that of Oberbeck, in which the coil of known resistance and unknown self-induction forms one branch of a Wheatstone bridge, the coil of an electrodynamometer takes the place of the galvanometer, and a zinc inductor that of the battery. The Maxwell-Rayleigh method requires accurately known resistances, a good ballistic galvanometer, and a constant temperature. The accuracy of the resistances and the constancy of the temperature are not so essential in Oberbeck's method, but the latter requires a sensitive electrodynamometer of rather high resistance and low inductance, and a constant source of sinusoïdal E.M.F. Oberbeck's method has the advantage of being in a certain sense a null method, since two points of equilibrium must be obtained, one with a continuous and the other with an alternating current, corresponding to the two enduring and two ballistic deflections in the other method. On the other hand, a galvanometer is far superior to an electrodynamometer in sensitiveness when the latter contains no iron, and iron is excluded by the fact that its presence would make the self-induction a function of the current. In the case of very small self-inductions, the joulean heat developed renders the Maxwell-Rayleigh method inaccurate. E. E. F.

1912. *Conductivity of Lead Peroxide.* **T. Sundorph.** (Wied. Annalen, 69. 1. pp. 319–323, September, 1899.)—Peroxide of lead, when used as a coherer substance, decreases in conductivity under the impact of electric waves. In one experiment the current decreased from 8·5 to 5 milliamperes in twenty minutes. At the same time the amount of PbO_2 was slightly reduced, but the author gives no explanation of this reduction. He observed that whatever took place was confined to the neighbourhood of the two terminals, and that the positive pole became hotter than the negative pole. E. E. F.

1913. *Measurement of Resistance by Damping.* **R. H. Weber.** (Wied. Annalen, 68. 4. pp. 705–728, August, 1899.)—In measurements of the resistivity of bodies like copper-zinc alloys containing more zinc than copper, it is impossible to obtain the substance in a form suitable for testing by the ordinary methods, owing to the brittleness of the alloys of that composition. The author has, therefore, worked out a new method, in which the material can be used in the form of plates or thick cylinders. Either a magnet is made to vibrate over a disc made of the alloy, or a cylinder of it is made to oscillate in a magnetic field. The damping produced by the induced currents forms a measure of the specific resistance, the logarithmic decrement being directly proportional to the conductivity. The accuracy is considerable, the errors not exceeding 0·7 per cent. in the case of alloys and amalgams. A further advantage of the method is that the material examined need not be subjected to strong mechanical manipulation such as is, for instance, involved in wire-drawing. A somewhat modified method consists in observing the deflection of the body in a rotating field. This is not quite so satisfactory, owing to the slipping of the zero, but it has the advantage of being suitable for electrolytes as well as foı metals. E. E. F.

1914. *Insulation of Three-Wire System.* **J. Kollert.** (Elektrotechn. Ztschr. 20. pp. 179–180, 1899.)—The author gives a method of finding inferior limits of the insulation resistances of the three wires taken separately when a galvanometer of known constant is introduced between each wire separately and earth, and the current strength is observed in each case. E. E. F.

1915. *Influence Machine.* **W. R. Pidgeon.** (Phil. Mag. 46. pp. 564–567, 1898.)—This is a simple machine in which each sector is embedded in an insulator, with the exception of a brass contact knob. It therefore carries a double charge, and the machine is, for the same surface, four times as effective as a Wimshurst machine. E. E. F.

1916. *Wehnelt Interrupter.* **W. J. Humphreys.** (Phys. Rev. 9. pp. 30–40, July, 1899.)—As negative electrodes, sheets of lead, copper, amalgamated copper, and coils of copper wire may be used with equal success. As positive electrodes, platinum wire or foil may be used; but the larger the exposed positive surface, the more current is necessary, the less frequent are the interruptions, and the greater the intensity of the secondary discharge. The distance between the electrodes is practically unimportant, and their relative positions are unimportant provided that the gases formed at the positive electrode can be easily and quickly replaced by the electrolyte. The platinum wire forming the positive electrode is held in a tube of soft German glass, external contact being made by mercury within the tube; to prevent subsequent cracking, the platinum is sealed into the tube with a bead of blue enamel glass. After long use, that part of the platinum which is in the electrolyte becomes pitted and frosted; and the part in contact with mercury within the tube becomes very perfectly amalgamated. The author ascribes the pitting to the action of electric discharges. Those electrolytes that conduct best give the best results with the interrupter, they also give the most vigorous action when their concentrations are such as to give the best conductivities at the temperature at which they are used. To prevent acid spray and change of bulk of the electrolyte, a layer of paraffin oil should be poured over the surface; the electrodes may be dipped in and out through the oil without hindrance to the efficiency of the interrupter. When there is no glow the current is not interrupted; but when there is no break there may still be a glow on a part of the anode, suggestive of brush discharges. Examined with a revolving mirror, the glow is seen to be intermittent with total absence of light at the intervals. The spectrum shows the lines of hydrogen and oxygen. Interruption is disturbed by a strong magnetic field; and may be completely stopped until the applied volts are increased. Increase of hydrostatic pressure lowers the frequency. The gases generated are different from those obtained by quiet electrolysis; there is a relatively small proportion of oxygen. As regards self-starting, if the voltage is just enough to work the interrupter the action begins wherever the circuit is closed; if the voltage is high, the electrode must be immersed before closing the circuit. The positive electrode has three stable conditions of activity: (1) the high-resistance stage, corresponding to very small currents; (2) quiet electrolysis; (3) the stage of regular interruption, corresponding to large currents. With very small self-induction, the action can only be obtained with very small anodes. Decrease in the self-induction causes increase in average current. For X-ray work the best results are obtained with an interrupter giving a frequency of about 300 per second; higher frequencies cause the tube to light up throughout. The author suggests that the action of the interrupter depends upon electrical discharges. The current first increases, on account of the self-induction, until the electrode is completely sheathed by a layer of gas, almost entirely oxygen. This gas abruptly breaks the circuit, and owing to the self-induction there is now an electrical discharge across the layer, giving rise to the glow, and at the same time decomposing some of the liquid. The sudden freeing of these gases and the heat of the discharge together produce an explosive effect; when this is over, the liquid falls back to its place, and the action is continued. R. A.

1917. *Wehnelt Interrupter.* **É. Hospitalier.** (Soc. Int. Elect. Bull. 16. pp. 248–255, 1899.)—This is a summary of the work done on the Wehnelt interrupter up to April last, together with a description of some original experiments. E. E. F.

1918. *Caldwell Interrupter.* **A. G. Cooke.** (Elect. Rev. 44. pp. 888–889, June 2, 1899.)—In the modified Wehnelt interrupter designed by Caldwell and Simon, the small orifices are gradually enlarged, the glass presenting a ground appearance. At the same time, acid is drawn through from the larger into the smaller partition. E. E. F.

1919. *Wehnelt Interrupter.* **H. T. Simon.** (Wied. Annalen, 68. 4. pp. 860–868, August, 1899.)—The form of interrupter described consists of a lead vessel filled with dilute sulphuric acid. An ordinary wide test-tube, attached to an ebonite lid, projects down into the acid. It contains a cylinder of sheet-lead, serving as a second electrode, and the bottom of the test-tube has several perforations about 1 mm. wide. In another form of the apparatus, a rectangular glass vessel is divided into two partitions by means of a thin plate of glass containing a few perforations. The two partitions contain electrodes identical in shape. In a third form, which, however, is of more theoretical than practical interest, the two vessels are joined by an inverted U-tube containing liquid nearly interrupted by a bubble at the top. The second type is that usually adopted. Slits may be substituted for the holes. The interrupter operates equally well for continuous and alternate currents, and interrupts both phases of the latter. It is not spoilt by the heat developed. E. E. F.

1920. *Instantaneous Contact-Maker.* **J. Haralson, Jr.** (Elect. World and Engineer, 34. pp. 83–84, July 15, 1899.)—A hard rubber disc is attached to one end of a shaft, the other end of which is attached to the shaft of the machine to be tested by means of a universal joint. A cast-iron ring is attached to the disc, and in an opening in this ring is placed a piece of steel spring embedded in fibre. This piece of spring is connected by a wire to a brass ring fitted over the hard rubber disc. A brush bearing on this brass ring is therefore in continuous connection with the steel spring. Another brush bearing on the cast-iron ring makes contact with the spring once in a revolution. To take a curve of E.M.F., the instantanteous E.M.F. of the machine is compensated by a potentiometer, equality being indicated by the absence of noise in a telephone receiver. E. E. F.

1921. *Cadmium Standard Cells.* **J. Henderson.** (Phil. Mag. 48. pp. 152–156, July, 1899.)—The author investigates how far reliance may be placed in cells constructed from "pure" materials, though not specially purified; also the effect of using moist crystals in place of solution, and acid salts instead of neutral salts. "Crystal" cells were found to be satisfactory, but not those containing solution. The author concludes that the cadmium cell is superior to the Clark cell. The effect of ordinary impurities is small, except free acid. It does not matter whether acid or neutral salts are employed. The mean temperature coefficient was found to be 0·005 per cent. per 1° C. Sudden variation of temperature should be avoided on account of time-lag. Depolarisation is rapid. W. R. C.

1922. *Magnetic Properties of Inorganic Compounds.* **S. Meyer.** (Wied. Annalen, 69. 1. pp. 236–263, September, 1899.)—The author has extended his magnetic researches to some 200 inorganic compounds of all the known elements. From the material thus accumulated he draws some important conclusions. The combination of two diamagnetic elements is always itself diamagnetic. Certain apparent exceptions are due to impurities. Compounds consisting of paramagnetic elements are not, however, necessarily paramagnetic. Thus the oxides of magnesium, aluminium, tungsten, thorium, and silicon are diamagnetic, and this cannot be explained by impurities. In any case it is not permissible to infer the magnetism of an atom from that of the molecule it helps to constitute. Polonium and radium are paramagnetic. The author has discovered quite a series of strongly magnetic elements, represented by the symbols, Pr, Nd, Yb, Sa, Gd, and Er. The last of these, erbium, shows in the form of the oxide a magnetic permeability four times that of Fe_2O_3. If the metal is more strongly magnetic in the same proportion as its oxide, a very important addition to our magnetic resources will have been made. As a rule, the molecular magnetism of paramagnetic compounds is smaller than the sum of the atomic magnetisms. In diamagnetic compounds the magnetism is simply additive. The author admits that valuable conclusions may be drawn from the magnetism of an element as to its molecular weight, and he expects that the molecular weights of radium and polonium will be found to be somewhere about 180, or above 230. E. E. F.

1923. *Magnetic Field within a Tubular Current.* **W. de Nikolaieve.** (Comptes Rendus, 129. pp. 202–203, July 24, 1899.)—Experiment shows that a magnetic pole placed within a tubular current experiences a magnetic couple. A. D.

1924. *Magnetic Properties of Hematite.* **A. Abt.** (Wied. Annalen, 68. 4. pp. 658–673, August, 1899.)—The hematite was derived from the neighbourhood of the great deposit of magnetite at Vaskö, Moravitza. Rough preliminary measurements revealed the fact that similar pieces of magnetite and hæmatite, subjected to the same magnetising current, gave deflections of the magnetometer standing in the ratio of 4 to 1. More detailed measurements showed that both the maximum magnetisation and the remanent magnetism of hematite depend largely upon the structure of the ore. One particularly homogeneous specimen, showing a percentage of iron rather in excess of that indicated by the formula Fe_2O_3, exhibited a remanent magnetism approaching that of magnetic iron ore within some 70 per cent. The maximum magnetic moments of three equal prisms, of pyrrhotite, hematite, and magnetite respectively, were found to be in the ratio of 1 to 2·356 to 3·237.

Pyrrhotite shows the smallest magnetisation in comparison with its percentage of metallic iron. In hematite, as in steel and in magnetite, the intensity of magnetisation increases with the length of the rod. E. E. F.

1925. *Hysteresis at Low Temperatures.* **A. H. Ford.** (Elect. World and Engineer, 34. p. 195, August 5, 1899.)—A sample of transformer iron was tested for hysteresis with a Ewing hysteresis tester at the ordinary temperature of the room. It was then plunged into a beaker of liquid air, allowed to cool, quickly removed, and tested while cold. Finally, another test was taken when the iron had attained the ordinary temperature. Four samples of the same kind of iron were examined in this way, and the mean results, giving the hysteresis loss in ergs per cycle per cubic cm., at the density of one gauss, were as follows:—

		% Increase.
Initial	0·00124	
Cold	0·00159	28
After warming	0·00139	12

Some other samples of the same kind of iron showed the following effect of heat treatment:—

		Hysteresis Loss.
Annealed from	835° C.	0·0014
Quenched in water from	225° C.	0·00125
Quenched in water from	400° C.	0·00145
Quenched in water from	804° C.	0·00150

A. H.

1926. *Normal Curve of Magnetisation of Iron.* **W. S. Franklin** and **S. S. Clarke.** (Phys. Rev. 8. pp. 304–309, 1899.)—It is likely that there are three distinct magnetising forces holding each other in equilibrium in a specimen of magnetised iron, viz.:—

(*a*) The impressed magnetising force including the demagnetising force due to the free magnetic poles of the specimen.

(*b*) A coercive or hysteretic magnetising or demagnetising force due to magnetic lag as the specimen is brought from one magnetic state to another.

(*c*) A demagnetising force due to a store of recoverable potential energy in the iron, or rather to a store of magnetic energy which is not yet dissipated by hysteresis. Thus, if V is the amount of this undissipated magnetic energy per unit volume, then V is a function of B, and $\frac{dV}{dB}$ is the demagnetising force due to V.

The function V may be determined indirectly by determining the curve of magnetisation under conditions in which the coercive or hysteretic force is obliterated, for, in this case the impressed magnetising force H and the demagnetising force $\frac{dV}{dB}$ are at each step in equilibrium, so that the curve of B and H obtained becomes the curve of B and $\frac{dV}{dB}$. This curve the authors call the *normal curve of magnetisation*.

Two methods are employed for the obliteration of the coercive force in the determination of $\frac{dV}{dB}$. In one method the iron specimen is subjected to the process of demagnetisation by reversals at each step. In the other method the iron specimen, which is in the form of a wire, is stretched by a constant force and set into violent longitudinal vibrations before each set of readings of B and H. For large impressed magnetising forces the operation of demagnetisation by reversals does not entirely obliterate coercive force.

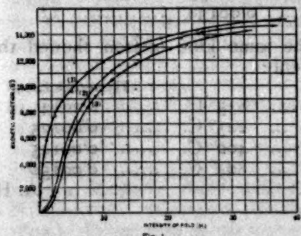


Fig. 1.

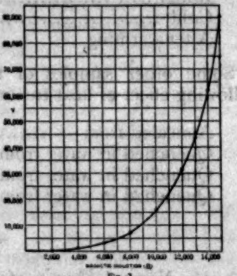
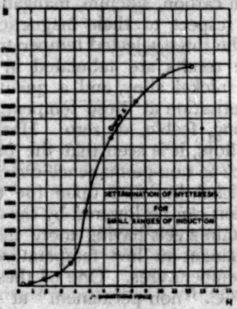


Fig. 2.

In the figures curve 1 gives the results obtained when at each step the specimen is subjected to the operation of demagnetisation by reversals. Curve 2 gives the results when subjected to violent longitudinal vibrations. Curve 3 gives the results when the specimen was magnetised in the ordinary way from a neutral condition. The curve in figure 2 gives the values of the energy function V for various values of B as determined by integrating the curve 1. W. G. R.

1927. *Hysteresis Loss for Small Induction.* **H. S. Webb.** (Phys. Rev. 8. pp. 310–314, 1899.)—The method used for determining the hysteresis loss is due to W. S. Franklin, and consists in weighing by a balance the force necessary to reverse the magnetism in the iron. The energy per cubic centimeter lost in the iron in one cycle is equal to the force measured by the balance in dynes divided by the area of the iron specimen.



The results obtained are embodied in curves, one of which is reproduced. W. G. R.

1928. *Magnetism and Molecular Rotation.* **Kelvin.** (Phil. Mag. 48. pp. 236–239, August, 1899.)—The author, in the light of Zeeman's experiments, renounces the old tempting gyrostatic hypothesis on the ground that no simplifying suppositions as to the character of the molecule, such as symmetry of forces and moments of inertia round the axis of the ring, can possibly give Zeeman's normal result of the splitting of a bright line into two sharp lines circularly polarised in opposite directions, when viewed parallel to the lines of force. Lorentz's theory, as expressed in Zeeman's first paper, he regards as essentially true. But he develops a novel conception of the magnetic molecule which goes some way towards accounting for the phenomena of diamagnetism. Each molecule is figured as an endless tube of non-conducting matter, "vitreously" electrified, and filled with an incompressible non-conducting fluid charged with an equal quantity of "resinous" electricity. In a magnetic field the fluid and the tube will experience equal and opposite tangential forces, and the tube will give rise to ether waves, while the fluid will rotate and continue rotating as long as the field is constant. This rotation, however, constitutes kinetic energy, and hence the field will contain more energy where it is strong than where it is feeble, and the molecules will crowd towards the feebler portions of the field. E. E. F.

1929. *Magnetic Transformation-point of Nickel Alloys.* **L. Dumas.** (Comptes Rendus, 129, pp. 42–45, July 3, 1899.)—Alloys of nickel with carbon, silicium, manganese, and chromium are examined with respect to their magnetic permanence and non-permanence at the three selected temperatures 15° C. – 78° C. and – 188° C. The results are tabulated in a form giving the constitution of each nickel alloy, and a qualitative statement as to whether its magnetisation at those temperatures is permanent, non-permanent, strong, feeble, or zero. Having regard to the constitution of the alloys, it is seen that the point of transformation from permanence to non-permanence depends not only upon the proportion of nickel, but also upon the temperature. The point of transformation can be lowered by the addition of carbon or manganese. Certain steels having more than 24 per cent. of nickel are non-permanent at low temperatures, others acquire permanence at low temperatures. One of these alloys is marked "permanent" at 15° C. "non-permanent" at – 78° C. and again "permanent" at – 188° C. Carbon clearly preponderates in the power of bringing about this kind of change, especially when combined with chromium. R. A.

1930. *Magnetic Pyrites.* **G. Sagnac.** (Paris, Soc. Franc. Phys. Bull. 131. pp. 4–5, 1899.)—Apparatus described, devised by M. Weiss, for showing that magnetic pyrites has two rectangular directions, of which one is magnetic, the other not. (See also 1899, Abstract No. 713.) A. D.

1931. *Magnetism and the Thermoelectric Properties of Bismuth and its Alloys.* **G. Spadavecchia.** (N. Cimento, 9. pp. 432–446, June, 1899.)—Variations in the thermoelectric E.M.F. of the alloys of bismuth and tin under the influence of a magnetic field increase with increase of the variations in that field, and have different values according to the direction of the magnetisation. Under the influence of a given magnetic field the variations of the thermoelectric E.M.F. diminish from pure bismuth to an alloy containing 0·113 per cent. of tin, changing sign between 0·056 per cent. and 0·113 per cent.; then the variations increase up to 0·237 per cent., changing sign between this and 2 per cent. The sign changes again for an alloy between 80 and 83 per cent. of tin. A. D.

1932. *Comparison of Magnetic Instruments.* **L. Palazzo.** (Roma R. Accad. Lincei Atti, 8. pp. 386–392 and 443–447, 1899.)—This is the report of the Italian Commissioner who carried out a comparison of the instruments used in the magnetic survey of Italy with those of Parc Saint-Maur and Kew. The following are the differences in the readings, as observed when simultaneous readings were taken with the instruments in question :—

	Rome—Parc Saint-Maur.	Rome—Kew.
Declination	+0'·6	−0'·7
Dip	−1'·2	−0'·7
Horizontal Force	−0·00009	−0·00006

E. E. F.

1933. *Magnetometer Observations and Atmospheric Pressure.* **G. Bellagamba.** (Roma R. Accad. Lincei Atti, 8. pp. 529–534, June, 1899.)—The time of vibration of a suspended magnet depends to some extent on the barometric pressure, as is proved by putting the magnet in an air-tight box, and varying the pressure by means of a pump. The variations, proportionately greater with a light than with a heavy magnet, are so small as to be negligible in determinations of the horizontal intensity of the earth's magnetic field. A. Gs.

1934. *Magnetic Elements of Potsdam.* **M. Eschenhagen.** (Wied. Annalen, 68. 4. pp. 917–918, August, 1899.)—The mean values for 1898 were computed from the hourly values of all days. They are as follows :—

	1898.	Difference : 1898–1897.
Declination	10° 5'·0 W.	−4'·7
Horizontal Force	0·18794 c.g.s.	+0·00019 c.g.s.
Vertical Force	0·43408 c.g.s.	+0·00010 c.g.s.
Dip	66° 35'·3 N.	−1'·0
Total Force	0·47302 c.g.s.	+0·00016 c.g.s.

Pronounced disturbances were observed on March 15th and 16th, and September 9th, and minor ones on fourteen other days. The disturbances show an increase over last year. E. E. F.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1935. *Transition-Points.* **H. Le Chatelier.** (Comptes Rendus, 129. pp. 497–499, September 25, 1899.)—The author states that the existence of fixed transition-points and fixed tensions of dissociation are more a matter of theory than of experiment, and points out that the phase rule cannot be applied directly to infinitesimal quantities of substance where the internal pressure on a particle, due to surface tension, depends largely on the magnitude of the particle. T. M. L.

1936. *Electrical Reaction-Velocity.* **E. Cohen.** (Zeitschr. Elektrochem. 6. pp. 85–87, July 27, 1899.)—If two elements are placed in circuit, each with one electrode reversible as to the anion, and the other electrode reversible as to the cation, and differing only in that the electrolytic salt-solution is saturated with regard to the stable form of the salt in one element, but with regard to a metastable form in the other, the resultant (differential) E.M.F. of the combination affords an electrical measure of the maximal energy liberated in the change from the metastable to the stable form of the salt. Thus in the case of two Clark elements, one saturated with regard to the salt $ZnSO_4\ 7\ H_2O$, and the other with regard to the salt $ZnSO_4 . 6\ H_2O$, there is a difference of E.M.F. which increases from 0 at +39° C. to 16·2 millivolts at −5° (Jäeger, Wied. Ann. 63. 345, 1897). The velocity of change is proportional to the current $C = E/\Sigma R$. The author has shown (Zeit. Phys. Chem. 1899, 28. 723) that the resistance of a Clark cell is proportional to that of a saturated solution of zinc sulphate at the same temperature, and therefore for two cells of equal dimensions $C = E/k\ (\omega_1 + \omega_2)$, where $\omega_1\ \omega_2$ are the specific resistances of a zinc sulphate solution saturated with regard to the salts $ZnSO_4 . 7H_2O$ and $ZnSO_4 . 6H_2O$. At the transition-point, 39° C., both salts are equally soluble and $\omega_1 = \omega_2 = 0{\cdot}0237$; below the transition-point the salt $ZnSO_4 . 7H_2O$ is less soluble, and ω_1 increases steadily to 0·0491 at −5°, whilst ω_2 increases to 0·0577. The electrical velocity-constant is $C' = E/(\omega_1 + \omega_2)$, and when calculated from this formula is found to rise from 0 at 39° to a maximum value $C' = 167{\cdot}6$ at 9°, and then to decrease to $C' = 151{\cdot}7$ at −5°. The occurrence of a maximum velocity of change is in accordance with the similar observations of Tammann (Zeit. Phys. Chem. 23. 326, 1888), on the velocity of crystallisation of supercooled liquids. T. M. L.

1937. *Electrical Determination of Saturation-Point of Solutions.* **J. H. van't Hoff.** (Zeitschr. Elektrochem. 6. p. 57–61, July 20, 1899.)—In this paper, read before the annual meeting of the German Electrochemical Society, the author describes a method, based upon the experiments of Dawson and Chiacaviglio, for determining the saturation-point of solutions of two or more salts, such as magnesium chloride and magnesium sulphate, with the corresponding sodium and potassium salts. The disadvantage of the usual specific gravity method of determining this point is, that the variation of specific gravity is slight for considerable difference of composition; and under certain conditions the specific gravity determination leads to incorrect conclusions as to the relative percentage of salts in solution.

The new method consists in measuring the electrical resistance of the solution, at intervals, between two fixed platinum electrodes. This method gives a much wider range of variation for mixed salt solutions of varying degrees of saturation, but is not free from the objection that at times solutions of different composition give the same electrical resistance. The author is now experimenting with a modification of the method in which the difference of potential between a mercury anode and calcium kathode is taken. Drawings of the apparatus used are given.

J. B. C. K.

1938. *Hydrolysis of Stannic Chloride.* **W. Foster, Jr.** (Phys. Rev. 9. pp. 41–56, July, 1899.)—The conductivity of solutions of stannic chloride in water is found to increase with time, becoming constant in fairly dilute solutions at values approximately the same as that of equivalent HCl solutions, whence complete hydrolysis is inferred. The change is rapid at high dilutions (complete in two or three hours), and slower at medium concentration, but strong solutions are already constant before they can be measured. The molecular depression of freezing-point found by Loomis agrees with the above assumption.

B. B. T.

1939. *Influence of Pressure on Formation of Tachydrite.* ($CaCl_2 . 2\ MgCl_2 . 12\ H_2O$.) **J. H. van't Hoff** and **H. M. Dawson.** (Berlin Akad. Sitzber. 30. pp. 557–562, June 15, 1899.)—This investigation forms one of a series of researches which are being carried out with a view to explaining the formation of the Stassfurt salt deposits. The influence of pressure on the nature of the deposited salts has been here investigated, and for this purpose tachydrite ($CaCl_2 . 2\ MgCl_2 . 12\ H_2O$) was specially chosen, since it is formed from its components at the very convenient temperature of 22° C.

The temperature of formation of tachydrite under atmospheric pressure has been determined very accurately by the thermometric method, two experiments giving respectively 22·4 and 22·399° C. The influence of pressure was measured in the manokryometer, in which the pressure on the system is attained by means of the expansion accompanying the formation of tachydrite from its components, the result being a state of equilibrium between the tachydrite and the partially transformed $MgCl_2 . 6 H_2O$ and $CaCl_2 . 6 H_2O$. After a dilatometric determination of the temperature of formation under atmospheric pressure by working with the open manokryometer, the latter was closed, the temperature of the bath raised, and the pressure corresponding to the condition of equilibrium at this temperature was determined by reading off the volume occupied by the enclosed air column. The mean result is that the temperature of formation of tachydrite is raised 0·017° C. by an increase of pressure equal to 1 atmosphere.

The authors point out that, from thermodynamical considerations, the influence of pressure on the formation of other minerals occurring in the Stassfurt deposits must be of the same order of magnitude; and that, in comparison with the influence of temperature, the pressure exerts but little effect on the crystallisation which results in the formation of oceanic salt deposits. Assuming a maximum pressure of 180 atmospheres, the effect of the latter in the case of tachydrite corresponds to a variation in the temperature of only 3° C. J. B. H.

1940. *Dissociation and Dielectric Constants.* **H. Euler.** (Zeitschr. Phys. Chem. 28. pp. 619–628, 1899.)—Polymerised bodies possess as a rule high dielectric constants. A case is quoted in which the molecular conductivity of a salt diminishes as dilution increases, and the author attempts to show that the dissociating force increases with the number of ions in the solution. E. E. F.

1941. *Electrolytic Evolution of Hydrogen.* **A. Coehn.** (Zeitschr. Elektrochem. 6. pp. 37–41, July 13, 1899.)—The electromotive force necessary to electrolyse water so as to cause bubbles of gas to be given off must exceed a certain minimum, this minimum depending on the metal of the electrodes. Caspari has carried out an investigation on this subject, the results of which have not yet been published, but Coehn gives here a few of them.

The E.M.F.s measured between the cathode of the metal and a constant hydrogen electrode, when bubbles of hydrogen are beginning to form, are as follows:—

Pt (platinised)...	0·005	Pd..............	0·48
Au	0·02	Sn..............	0·53
Pt (ordinary) ...	0·09	Pb..............	0·64
Ag	0·15	Zn..............	0·70
Cu	0·23	Hg	0·78

Were the evolution of hydrogen a reversible phenomenon these numbers would in every case be zero, while the difference of potential between the hydrogen electrode and the anode would be 1·08 volts. It is evident that with platinised platinum the condition of reversibility is practically fulfilled.

Coehn has already given an expression for the condition that hydrogen bubbles should be evolved in the case when the action is reversible. He now introduces into this expression another factor for the above excess E.M.F. which prevents reversibility, and in the expression so modified he considers the effects produced by varying the various factors, such as concentration of the ions of H, or the ions of the metal in salt solutions, the osmotic pressure, &c. He illustrates by means of the formula the different ways of preventing the solution of zinc in sulphuric acid solution :—By diluting the acid ; by amalgamating the zinc ; by introducing $ZnSO_4$. He also illustrates the fact that lead can be deposited electrolytically from an acid solution, while zinc cannot be so deposited.

The particular property of the metal on which he considers the excess E.M.F. depends is the solubility of hydrogen in the metal.

Ostwald, in his discussion, attributes the excess E.M.F. entirely to the surface of the metal, and is led to this conclusion by the fact that with liquid electrodes the same value of this excess E.M.F. is obtained with amalgams of Zn, Cd, &c. as with pure Hg. If electrolysis is carried on very slowly, he considers a continuous state of things may be kept up by diffusion without any hydrogen bubbles being liberated at the kathode. If, however, bubbles are to be liberated, a certain extra amount of work will be required to supply the energy necessary to create the first small bubble. Assuming the first bubble to have infinitesimal dimensions, an infinite pressure would be required, and infinite supersaturation. Assuming molecular dimensions only, the necessary supersaturation is beyond all known limits, but the potential comes out less than that experimentally determined for Hg.

Ostwald thinks that velocity must enter into the question, and that different values of the potential necessary to form the first bubble would be obtained with different time limits. It is possible that the H, which has been separated out as ions, has no charge at first, and that the reaction $2H = H_2$ in the dissolved state takes some time. Then this single atom H would have greater solubility in the liquid and a much smaller super-pressure of solution or super-saturation would be necessary to give the same potential.

Bredig attributes the phenomenon to combination of the H with the metal of the kathode similar to the combination of a Na kathion with the metal of the kathode which he proved to occur with heavy current densities. J. B. H.

1942. *Electrolysis away from Electrodes.* **F. T. Trouton.** (Electrician, 43. p. 294, June 23, 1899.)—Two beakers, one placed within the other, contain the electrolyte, and one electrode is placed in each. The inner beaker is perforated with a small hole, so that the arrangement practically forms a Caldwell interrupter. When a current passes at a minimum pressure of 800 volts continuous, or 500 volts alternating, a blue glow appears, and oxygen and hydrogen are evolved at the hole. The continuous currents varied between 0·3 and 0·08 ampere. The oxygen always appeared in the inner beaker, no matter what the direction of the current. W. R. C.

1943. *Organic Electrolysis by Alternating Currents.* **M. Krüger.** (Elektrochem. Ztschr. 6. pp. 29–32, 1899.)—This is a short summary of the work of Drechsel and Gerbes on the effect of alternate-current electrolysis on ammonium carbamate, and that of the former author on its effect on certain other organic solutions, with a hypothetical explanation of the action. W. G. M.

1944. *Electrolysis of Platinum Chloride.* **W. Dittenberger** and **R. Dietz.** (Wied. Annalen, 68. 4. pp. 853–859, August, 1899.)—The authors tested Kohlrausch's supposition that platinum chloride in solution takes the form H_2PtCl_4O, and that during electrolysis it splits up into the ions H_2 and $PtCl_4O$, the metal thus going to the anode. They consider it more probable that chloroplatinic acid is formed (which possesses a much higher conductivity than fresh platinum chloride solution) according to the formula, $2\ H_2PtCl_4O = H_2PtCl_6 + PtCl_2O + H_2O$. Stannic chloride also shows an anomalous behaviour of this kind, a small amount of tin being conveyed to the anode.

E. E. F.

1945. *Electrolysis of Hydrochloric Acid.* **D. Tommasi.** (Elect. Rev. 45. pp. 469–470, September 22, 1899.)—Electrolysing hydrochloric acid with currents at 1·02, 1·42, and 2·04 volts, the author observed that the platinum anode is dissolved only in concentrated HCl of density 1·2. Diluted acids yielded oxides of chlorine, about which no particulars are stated. H. B.

1946. *Electrolysis of Alkali Chloride Solutions.* **Foerster.** (Zeitschr. Elektrochem. 6. pp. 11–26, July 6, 1899.)—In this paper, read before the annual meeting of the German Electrochemical Society, Foerster reviews the experimental work of

Fogh, Oettel, Haber, Wohlwill (see 1899, Abstract No. 341), Winteler (see 1899, Abstract No. 1407), and Muller (see 1899, Abstract No. 1408), and discusses the results obtained by them in their relation to those obtained by Jorre and himself. The paper is unsuited for useful abstraction; but Foerster thus summarises the bearing of these researches upon the industrial utilisation of electrolysis for chlorate production :—

1. The reduction at the kathode should be minimised as far as possible, either by formation of a skin of calcium hydrate or by the use of potassium chromate. (See Muller's researches.)

2. The electrolyte should be slightly acid, in order that free hypochlorous acid may be produced.

3. A large volume of electrolyte should be used, and it should be constantly agitated, in order to promote those secondary reactions requiring time for their completion.

4. A temperature of at least 40° C. should be maintained—to promote the secondary reactions named above, to reduce the necessary E.M.F. for a given current density, and to minimise the formation of perchlorates.

In closing his paper, Foerster stated that the ideal process for chlorate production should reach the efficiency attained in the electrolysis of a solution of pure calcium chloride, with which current efficiencies of 87 per cent. could be constantly maintained. It is possible that in time the efficiency obtained on an industrial scale will approach this figure. J. B. C. K.

1947. *Position of Industrial Electro-Chemistry.* **W. Borchers.** (Zeitschr. Elektrochem. 6. pp. 61–80, July 20, 1899.)—This paper was prepared for the last annual meeting of the German Society of Electrochemists, in response to a request made by the Committee to Dr. Borchers at the meeting of 1898. It contains a statement of the power utilised and available at every electrochemical or electrometallurgical works now in existence, together with the names of the owners and of the engineers who supplied the plant and machinery; but as the information in Dr. Borchers' possession is incomplete, there are many gaps in the table in which this information is gathered together.

A diagram showing the extent to which electricity is used in the production of the more important metals or non-metals, and tables showing the estimated weight and value of this output, are also given in the original paper. The remaining portion of the paper discusses the current efficiency of the Hall and of the Heroult aluminium extraction processes, as revealed by the outputs of the works using these processes, and the possibilities of aluminium and of calcium carbide as energy carriers.

J. B. C. K.

1948. *Electrical Bleaching.* **V. Engelhardt.** (Elektrochem. Ztschr. 6. pp. 28–29, 1899; also Oesterr. Chemiker-Zeitung, Wien, 1898, 13.)—O. Prelinger, in the bleach-works of F. Gebauer in Charlottenburg, has obtained practical results on a large scale with a Kellner electrolytic cell attached to a tank, maintained at 20°–25° C. by a cooling worm (to prevent the formation of chlorates), and provided with a centrifugal pump and circulating pipes of hard lead. When 650 litres of sodium chloride solution of 10° Bé (110 kg. NaCl per cb. m.) were thus circulated for three hours with a current of 114 amp. and 112 volts (=19 H.P. hrs.) passing, the solution finally contained 0·85 per cent. active chlorine, or 5·5 kg. of active chlorine in the whole solution. Reckoning the price of salt at 96 kr. per 100 kg., and that of power at 1·41 fl. per 100 H.P. hrs., and taking the amortisation of the plant (at 10 per cent.) as 48 kr., the cost of the whole operation was 1·90 fl., which is equivalent to 36 kr. per kilogramme of chlorine. In a comparative experiment on 33,800 m. (2,800 kg.) of light cotton cloth, the electrolytic bleach (with 2·81 grm. of available chlorine per litre) and subsequent treatment with hydrochloric acid cost 2·52 fl., whilst a chloride of lime bleach cost 8·34 fl. In another experiment on the same scale the relative costs were 5·07 and 12·63 fl.

W. G. M.

1949. *Electrolytic Ozone.* **E. Andreoli.** (Électricien, 18. pp. 145–147, September 2, 1899.)—This article is a history of the early attempts to make ozone by the electrolysis of solutions, usually of an acid. Schoenbein is cited as the earliest worker in this field and the results he obtained are given. Soret in 1854 showed that the temperature of the solution had a marked effect on the amount of ozone formed, and his own and other figures are quoted, while the theories of Lupke, Le Blanc, Berthelot &c., are discussed. Finally, the author points out that Rhumkoff's coil has entirely superseded the electrolytic method, and that there is in fact no more recent patent for the latter than that of Donovan in 1860. The author asks whether the electrolytic method might not now be utilised in some special cases to advantage, considering the immense improvements that have been made in all the apparatus &c., for such work. J. L. F. V.

1950. *High-Temperatures by means of Aluminium.* **H. Goldschmidt.** (Zeitschr. Elektrochem. 6. pp. 53–57, July 20, 1899.)—In this paper, read before the annual meeting of the German Electrochemical Society, the author reports upon the technical utilisation of his process for obtaining high temperatures by means of powdered aluminium. The details of this process were described in a previous paper before the Society. The applications of the method are three:—

1. The production of metals and alloys. Manganese, chromium, various alloys of these two metals, ferro-titanium and ferro-boron are being produced at Essen by a company called the "Chemische Thermo-Industrie," and the industrial utilisation of the process is about to occur in France.

2. The production of artificial corrundum. This by-product of the reduction of metallic oxides by powdered aluminium is finding a ready sale for various purposes.

3. The production of heat for metal-working operations. The method is being used for hardening, for hard soldering, for welding, and other operations. The localisation of the heat is an important characteristic of the process. Its use for rail-bonding by welding on electric tram-lines, has been successfully initiated at Essen.

Defective parts in steel-castings can be made good by this method. J. B. C. K.

1951. *Magnetic Ore Separators.* **H. C. McNeill.** (Electrician 43. pp. 639–640, August 25th, and pp. 674–675, September 1, 1899. Abstract of paper read before the Iron and Steel Institute.) —A description is given of the following systems for the magnetic concentration of ores: Wenström, Monarch, Dellvik-Gröndal, Heberle, and Wetherill. W. R. C.

GENERAL ELECTRICAL ENGINEERING.

1952. *Iron-Consuming Batteries.* **J. Waterhouse.** (Soc. Chem. Ind. Journ. 18. pp. 559–560, June, 1899.)—An account of using iron instead of zinc in Daniell cells. No trouble occurred through deposits of basic iron. W. R. C.

1953. *Germain's Primary Battery.* (Écl. Électr. 19. pp. 422–424, June 17, 1899.)—This battery, which has come largely into use, is a form of Leclanché in which the electrolyte is retained between the plates by cellulose. Curves of discharge are given. W. R. C.

1954. *Aron Energy-meter with Automatic Rewinding.* **J. Reyval.** (Écl. Électr. 19. pp. 377–384, June 10, 1899.)—The chief defects of the old type of Aron meter were the necessity of periodical winding, of careful adjustment of the pendulums to synchronism in position, and the want of automatic starting of the pendulums. All these defects, with others, are removed in the new model, which has been accepted as accurate by the Austrian Government. The theory of the instrument is worked out [there is a misprint in a formula on page 379], and it is shown that in the old type the relative gain or loss of the pendulums was sensibly proportional to the energy consumed in the circuit. In the new pattern the pendulums are short, and vibrate so much faster than the long ones formerly used that a considerable error would be caused with the same method of control; this is eliminated by causing the current to act on both pendulums, so that while one gains the other loses with regard to the normal rate. The disturbing terms in the equations then vanish, while the error due to external magnetic fields is also minimised. The mechanism is described in detail, with numerous illustrations. As the synchronism of the short pendulums cannot be perfect, nor the magnetic reactions made identical in both cases, the resulting errors have to be neutralised by simultaneously reversing the direction of rotation of the clockwork and the current in the shunt coils, at intervals of about twenty minutes. The devices by which this is accomplished are minutely explained, as well as the self-winding mechanism, which consists of an electromagnet actuating a pawl and ratchet at intervals. There are two sets of differential gear, one for the driving and the other for the integrating device. The method of connecting the meter with the circuit is also described. Additional advantages claimed for this meter are permanence of standardisation, as there are no steel magnets; freedom from thermal, frictional, and magnetic errors; starting on very small loads; low consumption of power (1·8 watts in a 1,000 watt meter); and accuracy of records with alternating as well as direct current, no matter what the frequency or phase difference. A. H. A.

1955. *Long-Schaltner Supply Meter.* (Electrician, 43. pp. 155–156, 1899.) (See 1899, Abstract No. 603.)—The amount of copper deposited is measured by a weight which slides on a beam graduated in watt hours for any prearranged voltage of supply. Drop of volts on 100-volt meter is 0·7 at full load, viz., 10 amperes. A $CuSO_4$ solution of 1·080 specific gravity is employed, *i.e.*, with 1 per cent. sulphuric acid and 99 per cent. water. Accuracy within 2 per cent. at 1 to 10 amperes and 4 pei cent. at 0·15 ampere. M. O'G.

1956. *Lightning and Lightning Arresters.* **H. E. Raymond.** (Amer. Electn. 11. pp. 214–215 and 262–263, June, 1899.)—Leyden jar experiments seem to show that (1) the lower the voltage the smaller the effect of resistance upon the discharge; (2) the greater the capacity the less is the discharge affected by resistance; (3) the shorter the resistance for a given cross section the less its influence; (4) the discharge will be affected by any reactance to quite a considerable extent.

In the action of arresters on the line we note, first, that the discharge is opposed by considerable length of resistance, and but little by amount of resistance in ohms in shorter lengths; second, that the length of gap determines the striking-point of the arrester; third, that the inductance of the line introduces a favourable factor; fourth, that the capacity of the discharges affects the striking-point, in that for a given distance the greater the capacity the lower the striking tension; fifth, that reactance coils offer but little impedance to lightning discharges, and a considerable opposition to Leyden jar sparks; sixth, that the voltage of line discharge is much less than that of the Leyden jar, with a long gap in series with its circuit.

Considering the line as a condenser alternately charged by the atmospheric disturbances and discharging to earth at certain conditions of electrostatic unbalancing or dielectric strain, there are the following differences between this condenser and its action and the Leyden condensers and their action: the line is presumably of higher capacity, and certainly of greater self-induction; the lightning discharges are of much lower frequency, as is shown by the slight effect of a reactance coil upon them. These points explain the fact that an arrester with a short gap and a moderate resistance in series will take a line discharge in preference to one without resistance and with a longer gap. [See Abstracts Nos. 1387, 1389 (1898), and No. 605 (1899).] W. G. R.

1957. *Lightning Arresters.* **Bochet.** (Soc. Int. Elect. Bull. 16. pp. 184–207, 1899.)—This paper gives an illustrated description of various lightning arresters for the protection of electric lines, and contains also a discussion of the conditions which arresters should satisfy. W. G. R.

1958. *Fuse-wires for Air-lines.* **J. Mattausch.** (Zeitschr. Elektrotechn. Wien, 17. pp. 159–160, 1899.)—In localities where danger is likely to occur to aerial lines, owing to stray currents from other circuits or to lightning, it is proposed to introduce fuses into every span of wire. The fuses are arranged so that the line-wires exert no strain upon the fuse-wire; and when a fuse "blows," the line-wires are still upheld. To get this result an insulating shackle is introduced into each span to take the strain, and fuse-wire is used to establish electrical connection between the ends of the shackle. Various modifications are described. R. A.

1959. *Concentric Wiring.* **M. O'Gorman.** (Elect. World and Engineer, 34. pp. 228–231, August 12, 1899.)—A defence of this system is given—it does not affect telegraphs or the ship's compass. Leakage current, shocks, or fires are impossible; the quantity of copper and rubber in cables is diminished; lamps can be screwed into the same sockets as fittings if the latter break down. Concentric flexibles are smooth externally, and being at zero potential attract no dust. Switchboards are waterproof and cheap because single pole. A special method of testing cables is given. E. H. C.-H.

1960. *Electricity in Coal-Mines.* **H. N. Gardner.** (Amer. Electn. 11. pp. 373–375, August, 1899.)—This article deals chiefly with the various conditions to be met in designing electrical machinery for mining work, the chief of which are rough usage and dirt; some practical notes on the methods adopted are given. A. H. A.

1961. *Electrically Driven Workshop of the A. E. G.* (Electrician, 43. pp. 437–440, July 21, 1899.)—Up to 2·000 H.P. is absorbed by the three-phase electric plant of the Allgemeine Elektricitäts-Gesellschaft. The astonishing development of this factory is traced, and the electrically driven lathes and tools illustrated. A plan and elevation of the works is given. M. O'G.

1962. *Modern Workshop Practice.* **F. Bathurst.** (Elect. Rev. 45. pp. 275–279, August 18th, and pp. 299–303, August 25, 1899.)—A detailed description, with numerous illustrations, of the machine tools and methods in use in the workshops of E. Kolben and Co. A. H. A.

1963. *Electrical Machinery on Board Ship.* **A. Siemens.** (Electrician, 43. p. 815, September 29, 1899. Paper read before the British Association, 1899.)—The chief advantage of electric power on shipboard is the absence of clumsy and leaky pipes. The difficulty is the variations in the loads on auxiliary machinery. The strain on a winch often stops it. In such cases, shunt-wound motors driving through friction clutches are used, or else series-wound motors with a special cut-out arranged to break the main circuit on occasion and only allow a certain current to flow through a by-pass circuit. The author mentions an electric steering gear and rudder indicator as an example of the first method. E. H. C.-H.

1964. *Automatic Pressure Regulator.* (Electrician, 43. p. 573, August 11, 1899.)—The "Chapman" regulator for automatically varying the resistance in the shunt circuit of dynamos is described and illustrated. There are two solenoids, one of which is subjected to the potential difference to be regulated, and controls the other; the latter actuates a multiple-point resistance switch in series with the exciting circuit. The instrument can be compounded to give a rising pressure with increase of load, and can be applied to alternators as well as dynamos. A. H. A.

1965. *Thawing Water-Pipes with Electricity.* (Canad. Elect. News, 9. pp. 57–58, 1899.)—Frozen water service pipes are thawed by means of alternating currents passed through the pipes themselves. A pressure of 20 to 50 volts is used, obtained from a portable transformer connected with the street mains; a current of 200 to 400 amperes is passed through the frozen pipe until the water flows freely, which usually takes place in a few minutes. Details of actual cases are given. A. H. A.

1966. *Electric Engraving Machine.* **F. J. Patten.** (Elect. World and Engineer, 34. pp. 306–307, August 26, 1899.)—The electric pantograph described in Abstract No. 1824 (1899) is here applied to the process of engraving upon wood or metal. Instead of merely tracing the picture as in the pantograph, the stylus is arranged to cut or engrave the lines to any desired depth. R. A.

1967. *Wool Removed from Skins Electrically.* (Electrician, 43. p. 333, June 30, 1899.)—This is a description of an electrical knife made of a platinum iridium wire rendered incandescent by a current of about 60 amperes at 4 volts. W. G. R.

1968. *Portable Electric Drilling Machine.* (Elect. World and Engineer, 34. p. 105, July 15, 1899.)—This is a description of a drill driven by an electric motor with a 50 per cent. speed regulation, and manufactured by the Stow Company, of Binghamton, N.Y. W. G. R.

1969. *Electric Power in Steel-Making.* **E. B. Clark.** (Cassier, 15. pp. 441–455, 1899.)—A paper written in popular style, giving an account of the application of electric power to machines used in steel-making, *e.g.*, charging and drawing machines, gantry cranes, locomotive cranes, drills, punches, shears, and electromagnets for handling plates. The paper is accompanied by numerous photographic illustrations. A. S.

1970. *Installation of Steam Boilers.* (Elect. Rev. 44. pp. 973, 1010–1012, 1056–1057, 45. pp. 124–126, 177–178, 376–377, 426–428, 505–506, 735–736, 1899.)—An illustrated series of articles on the construction and erection of steam boilers. EDITOR.

1971. *Simple Steam Engine with Remarkable Economy.* (Amer. Electn. 11. p. 208, 1899.)—The steam engine designed by Elihu Thompson for steam automobile work has four cylinders each 2½ in. diameter and 3 in. stroke, all single acting and worked single expansion, the output of the four being about 5 H.P. The economy obtained with this small engine reached 20½ lbs. of water per H.P. hour, the steam pressure being between 160 and 200 lbs. with a considerable degree of superheating, the engine at times being worked with the steam-pipe red-hot. The steam is admitted to the cylinder by a simple poppet-valve, and expands until the piston uncovers the exhaust ports. The conditions are such that there is no retraversing of any of the passages by the steam. The steam is always moving in one direction, so that there are no inter-actions to cause waste of energy. A. S.

1972. *Electric Light and Traction Engines.* (Elect. Rev. 44. pp. 980–982, June 16th; 1069–1070, June 30th; 45. p. 24, July 7, 1899.)—A series of articles on the general design of steam engines for electric light and traction power stations. EDITOR.

GENERATORS, MOTORS, AND TRANSFORMERS.

1973. *Over-Compounding Dynamos.* **E. K. Scott.** (Elect. Rev. 45. pp. 428–429, September 15, 1899.)—The author describes a method of compensating for the curvature of the B–H curve by shunting the series coils with iron wire; as the load increases the resistance of the iron increases with rise of temperature more rapidly than that of the copper coils, thereby shunting a smaller proportion of the total current. It is remarked that over-compounding, by increasing the magnetic flux, tends to reduce sparking at the brushes. The common practice of specifying that dynamos for electricity works shall be designed for 460 volts for lighting, but shall be able to work at 550 volts for traction, is criticised on the score that the weak field in the former case conduces to sparking and involves increased first cost.

A. H. A.

1974. *Regulation of Alternating Current Generators.* **C. L. Cory.** (Journal of Electricity, 8. pp. 33–40, August, 1899. Paper read before the Pacific Coast Electric Transmission Association, San Francisco, June 20–21, 1899.)—The chief item affecting the regulation of alternators is the power factor of its load, since a load of low power factor means large wattless demagnetising current in the armature of the machine. W. G. R.

1975. *Crocker-Wheeler Motors for Special Purposes.* (Elect. World and Engineer, 34. pp. 140–141, July 22, 1899.)—The paper describes, among others, a motor specially designed for driving machinery which has to be stopped with precision. One pole-piece is hinged and forced away from the armature by a strong spring which at the same time tightens a band brake on a brake drum attached to the armature spider. When the field is excited the movable pole-piece is pulled toward the armature and the band brake released. The spring and brake band may be adjusted so that the armature is stopped and held firmly the instant the current is cut off, or it may be allowed to make a few revolutions before stopping. R. B. R.

1976. *Theory of Induction Motors.* **J. Heubach.** (Elektrotechn. Ztschr. 20. pp. 301–305 and 314–317, 1899.)—The first part of the paper is devoted to polyphase motors. Considering the field of the stator, the author remarks that the intensity of the field undergoes, in general, fluctuations consequent on the fluctuations in the inducing ampere-turns. He considers the two extreme cases in which the ampere-turns have (*a*) a maximum and (*b*) a minimum value, and draws diagrams (consisting of zigzag lines) illustrating roughly the distribution of the field in these two cases for a two-phase and a three-phase motor in which each side of a stator coil is distributed over three tunnels in the stator core. Next comes the calculation of the counter E.M.F. in the stator: this is determined by supposing the stator coils displaced, step by step, in a stationary field which resembles the rotating field of the motor, calculating the instantaneous values of the E.M.F. corresponding to each small displacement until a complete half-wave has been traced out, and then finding its R.M.S. value. The actual rotating field, is, however, a pulsating one; in applying the method just described for finding the E.M.F., the author overcomes the difficulty by considering the two cases (*a*) and (*b*) separately, and supposing that in each case the rotating field remains constant. The result of this investigation shows that the R.M.S. value of the E.M.F. is the *same* in each case, notwithstanding the fact that in case (*a*) the maximum field-intensity is higher. From this it follows that the total flux from a pole is not a constant quantity. The torque is next calculated on the supposition that the actual field of the motor is replaced by an equivalent sine field. The calculation of the torque involves the introduction of certain constants depending on the rotor winding and the breadth of its coils. The results obtained are applied to Heyland's diagram for the induction motor (Elektrotechn. Ztschr. 1896). The second part of the paper deals with the single-phase motor. The results obtained for polyphase motors may be applied to the single-phase motor by supposing the latter replaced by two equal and mechanically coupled polyphase motors whose inducing windings are connected in series in such a manner as to produce oppositely rotating fields. By this artifice the diagram of the single-phase motor may be deduced from the corresponding two diagrams of the equivalent pair of polyphase motors. The calculation of the primary field, primary counter-E.M.F., and of the torque, proceeds on the same lines as those already indicated for the polyphase motor. The paper contains valuable tables of the coefficients for different kinds of windings which are required in motor calculations, and the practical value of which has been tested by the author.

A. H.

POWER DISTRIBUTION, TRACTION, AND LIGHTING.

1977. *The Feeder System at Boston, U.S.A.* (Railway World, 8. pp. 237–244, July, 1899.)—The mileage operated is over 300 miles of single track, and the cables used comprise 510 miles of feeders and 70 miles of insulated return wires. The sections of copper were calculated from the following formula :—

$$S = \frac{1{\cdot}5\ PAMG^2}{V^2\,(G-1)}$$

where—

S = cross section of feeder in circular mils.
P = power delivered to cars in watts, nominal.
A = specific resistance of copper per mile-mil.
M = distance to centre of load, miles.
V = pressure at power station in volts.
$1{\cdot}5$ = a constant representing the ratio between total drop and feeder drop.
G = economical constant which may have any value between 1 and 2 and is determined by one of the following formulæ :—

For overhead lines—

$$G = 1 + \sqrt{\frac{2{\cdot}25\ M^2A\,(CD + E_oF_o)}{2{\cdot}25\ M^2A\,(CD + E_oF_o) + V^2\,(H\ I\ 8760 + JK)}} \quad \text{or}$$

For underground lines—

$$G = 1 + \sqrt{\frac{2{\cdot}25\ M^2A\,(CD + E_uF_u)}{2{\cdot}25\ M^2A\,(CD + E_uF_u) + V^2\,(H\ I\ 8760 + JK)}}$$

where—

C = cost of copper in dollars per mile-mil (copper only, and does not include cost of insulation and installing).
D = interest and depreciation on above amount.
E_o = cost of insulating and installing copper overhead per mile-mil.
E_u = cost of insulating and installing copper underground per mile-mil.
F_o = interest and depreciation on above amount for overhead lines.
F_u = interest and depreciation on above amount for underground lines.
H = time factor of energy lost in feeder.
I = cost of producing this energy per watt hour.

J = cost of generating plant per watt installed.
K = interest and depreciation on plant.

The average insulation resistance of the underground cable ranges from 200 to 1,500 megs. per mile. E. H. C.-H.

1978. *Electricity Works of Small Output.* **A. D. Adams.** (Amer. Electn. 11. pp. 263–264, June, 1899.)—The author discusses the problem of electric lighting for comparatively small towns generating their own electrical energy, and gives a comparison of the direct and alternating systems for such a purpose. W. G. R.

1979. *Plymouth Electricity Works.* (Elect. Engin. 24. pp. 102–110, July 28th, and pp. 146–149, August 4, 1899.)—These articles contain a full illustrated description of the Plymouth combined lighting and traction works. The lighting plant is 2,000 volts alternating and the traction plant 500 volts continuous current. One engine carries a dynamo and an alternator on the same shaft in order to deal economically with light loads. The coal arrangements are very complete, and the whole cargo of a 600-ton ship can be discharged in two days. Lancashire boilers without cross-tubes are used, worked at 130 lb. pressure, but constructed for 160 lb. to avoid reduction in working pressure as the boilers age. Instead of being individually lagged, a non-conducting floor has been formed over the battery of boilers. The motors of the electric 3-throw pumps are arranged with two totally distinct circuits to their armatures, so that they can be economically run at 730 r.p.m. when the two circuits are in parallel, or at 365 r.p.m. when in series. The feed and steam pipe arrangements have received particular attention. A ring steam main has been avoided. E. H. C.-H.

1980. *Potteries Electric Tramways.* (Railway World, 8. pp. 203–212, June, 1899.)—This system will comprise 35 miles of tramway on a 4-feet gauge. Current at 500 volts will be supplied to the whole system from two stations. The drop in the return circuit will be kept down by negative boosters. A full description is given of the power station at Stoke-on-Trent.
E. H. C.-H.

1981. *Bommern-Witten Tramway.* **M. Schiemann.** (Elektrotechn. Ztschr. 20. pp. 507–510, July 20, 1899.)—This is an illustrated description (9 figures) of a typical German electric tramway which has been equipped by the firm of O. L. Kummer and Co. of Dresden. The power station has steam-driven sets—150 lbs. steam, 135 revs. per minute, eight-pole dynamos—and there is also a buffer battery of accumulators. Three very clear diagrams of connections are given. The first shows the series parallel and brake connections of the motors at various points of the controller; the second is a car-wiring diagram; and the third gives the switchboard diagram arranged for four dynamos, the battery, and ten feeder circuits.

The station arrester described is a modified form of the Thomson circuit breaker, the curved horns of the latter being replaced by two carbon blocks — one adjustable — which are held on the ends of two steel cores which pass down the interior of the blow-out coil. E. K. S.

1982. *Electric Traction.* **A. D. Greatorex.** (Electrician, 43. pp. 627–629, August 25th; 676–677, September 1st; and 702–704, September 8, 1899.)—Abstract of a paper read before the Incorporated Association of Municipal Engineers, giving a brief description of the various systems of traction—overhead, conduit, accumulator, and combined—with estimates of their cost. E. H. C.-H.

1983. *Electric Traction Statistics as Data for Design.* **A. Hecker.** (Elektrotechn. Ztschr. 20. pp. 590–592, August 17, 1899.)—The author, after carefully investigating available statistics, finds that if abnormal cases be excepted, there are definite relations connecting the number of inhabitants with the gross receipts and the number of car-miles run. These relations may be expressed by the following formulæ:—

$$y_1 = 2{\cdot}5 \times 1{\cdot}12^{\frac{x_1}{4}-1}$$

where y_1 denotes the receipts per head per year, in shillings, and x_1 the number of inhabitants divided by 10,000. Further—

$$y_2 = 10 \times 1{\cdot}08^{\frac{x_1}{4}-1}$$

y_2 denoting the number of car-miles per year per inhabitant.

A. H.

1984. *Controlling Stray Currents on Electric Railroads.* (Elektrotechn. Ztschr. 20. pp. 427–429, June 15, 1899.)—This is the discussion on a paper read by **M. Kallmann** before the Elektrotechn. Verein, Berlin (see 1899, Abstract No. 1301). **Wagner** pointed out the very small loss in weight (100 grms.

and 205 grms.) of the two earth plates in the generating station at Spandau after 2½ years' running. **West** described a method of determining the resistance of rail joints by a Wheatstone Bridge test between three equidistant insulated axles of a special truck. **Kallmann** discussed the effect of joints on rail resistance, and described a laboratory experiment illustrating leakage currents, the methods of testing, and the effect of distance between feeding-points. **Glaisberg** pointed out that the electrolytic corrosion by stray currents depends on the absolute value of such currents and the distance between the feeding-points, which should therefore be made the basis of the regulations with regard to leakage, instead of the percentage leakage as specified by the English Board of Trade. L. B.

1985. *Indispensable Accessories of Electric Traction.* **H. E. P. Cottrell.** (Elect. Rev. 44. pp. 667–670, 711–713, and pp. 755–758, 1899.)—These, the first three of twelve fully illustrated articles on the above subject, deal with trucks. (pp. 843–846, 923–925, June 9, and 1051–1053, June 30, 1899): Brakes. (45. pp. 88–91, July 21, 1899): Roller bearings, life-guards, gongs, track-scrapers, sand-boxes, heaters. (pp. 211–214, August 4, 1899): Heaters and lighting. (pp. 260–262, August 18, 1899): Lighting couplings, commutator segments, brushes, circuit breakers, lightning arresters. (pp. 303–305, August 25, 1899): Trolleys, couplings. (pp. 349–351, September 1, 386–387, September 8, and 424–426, September 15, 1899): Bonding and welding. E. H. C.-H.

1986. *Overhead Line Material for Electric Railways.* **Benz.** (Elektrotechn. Ztschr. 20. pp. 493–498, July 13, 1899.)—A detailed description of trolley wire insulators, strain insulators, cross-wire suspension insulators, pull-over brackets, frogs, joints, &c., as made by the Allgemeine Elektricitäts-Gesellschaft of Berlin. Stabilit, a vulcanised fibre material, is used for the insulation, and the author gives its resistance after being kept in a damp atmosphere for four weeks at 8·5 megohms per cubic centimetre.

The article is illustrated by 48 figures, of which ten are line drawings in section. E. K. S.

1987. *Overhead Line Construction.* **A. B. Herrick.** (Street Rly. Journ. 15. pp. 277–281, 437–440, July, 513–515, August, 1899.)—Articles descriptive of the construction in detail of overhead trolley lines, including the proportioning of feeders.

EDITOR.

1988. *Rail-Bonding.* **R. D. Appleton.** (Railway World, 8. pp. 269–270, July, 1899. Paper read before the Railway and Electrical Association of Virginia, U.S.A.)—Bonds of solid copper become loose owing to expansion. Flexible bonds break off. Electric welding decarbonises the ends of the rails and results in two thumps per joint instead of the usual one. Cast welds are good mechanically, but their resistance is high, and gets higher with time. The ideal bond must absolutely prevent corrosion of contact surfaces by excluding water in spite of all variations of temperature. It must be able to give and take as much as an eighth of an inch per joint again and again without breaking or crystallising. It should be capable of carrying as much current as the rail itself. The author has in three years' experience found these qualities in the plastic bond. E. H. C.-H.

1989. *Electric Rail Welding.* (Elect. World and Engineer, 34. pp. 234–235, August 12, 1899.)—This is a short description of the electric rail welding plant of the Lorain Steel Company, Ohio, as employed in making 7,500 rail joints in the Buffalo street railway system. The trolley wire current is transformed by a rotary converter carried on the car into single-phase current of 300 volts, and then down to 5 or 7 volts by a static transformer of one secondary turn giving up to 25,000 amps. The joint is made by means of fishplates welded on to either side of the web under heavy pressure. Each joint takes fifteen minutes to complete. L. B.

1990. *Brake Shoes.* (Street Rly. Rev. 9. pp. 477–480, July, 1899.)—This paper gives an account of patents on brake shoes for the last thirty years, of tests prior to 1895, and a summary of the most recent experiments. A table showing the mean coefficients of friction is given, having been prepared from the data published in the Master Car Builders' Proceedings, from the Reports of Tests made for the Sargent Company, Chicago, and from the Reports of Tests by Goss of Purdue University. The tests were made at initial speeds of 65, 40, and 30 miles per hour respectively; and two diagrams are given showing the mean coefficient of friction, and the distance run before stopping on the assumption that each shoe has to absorb the energy of a mass of 12,000 lbs. As a rule, the coefficient of friction is less at the high speeds; the total variation over the experiments recorded being from 11 to 39 per cent. The effects of the various brake shoes on a chilled wheel and on a steel-tired wheel are recorded. A. S.

1991. *Thermal Tests for Car Wheels.* (Street Rly. Rev. 9. pp. 486–487, July, 1899.)—Goss and Smart of Purdue University

TELEGRAPHY AND TELEPHONY.

1995. *Mercadier's Multiplex Telegraphy.* (Elektrotechn. Ztschr. 20. pp. 305–307, 318–320, and 336–337, 1899.)—This system was described in the Annales Télégraphiques in 1891. It consists in "tuning" a set of telephones so that each responds to an alternate current of one, and only one, periodicity. These so-called "monotelephones" may be connected in series, one at each station, and any particular station can be signalled to by an alternating current of the appropriate periodicity. The present articles describe the arrangement of circuits and apparatus, and the author gives his reasons for believing that this system is more economical than those which have preceded it. R. A.

1996. *Wireless Telegraphy.* **J. J. Green.** (Amer. Electn. 11. pp. 344–346, July, 1899.)—Elementary description with photographs of apparatus. A failure to communicate across Chicago is ascribed to the direct line between the tops of the vertical wires being intercepted by telegraph wires. M. O'G.

1997. *Selector System of Circuits.* **E. Bernard.** (Elect. Rev. N.Y. 34. pp. 225–227, 1899.)—This is a translation in English of the article by J. Voisenat on the Bandot system of telegraphy. (See 1898, Abstract No. 1300.) R. A.

1998. *Telephone Exchanges.* **B. von Wehrenalp.** (Zeitschr. Elektrotechn, Wien. 17. pp. 331–340, June 14, 1899.)—A detailed description, with coloured charts, of the new system of telephone exchanges at Vienna. R. A.

1999. *Private Central Telephone Stations.* **Mandroux.** (Électricien, 15. pp. 122–125, 1898.)—Diagrams explaining "Monocord" systems as used by the French Government. (See 1898, Abstracts Nos. 462 and 463.) M. O'G.

2000. *Transmitter Working with 20 Volts.* **G. Dumont.** (Électricien, 17. pp. 305–308, 1899.)—By using a special granular material, in a modified box with receivers having an extended magnetic field, 20 volts can be used without producing harsh sounds, and with increased clearness on long lines. M. O'G.